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NUCLEAR SCIENCE ABSTRACTS

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GENERAL AND MISCELLANEOUS

3772 (APRL-E-38-7.1) STATIC STRESS DETERMINATIONS AND CRUSHED ZONE MEASUREMENTS SITE HOBO. Robert H. Merrill and Verne E. Hooker (Bureau of Mines. Applied Physics Research Lab., College Park, Md.). July 1960. 27p. Contract AT(29-2)-914. OTS.

Post-shot measurements were made to determine the static field near the shot sites and the volume of the crushed zone of rock surrounding the location of the charges fired during Project HOBO. These measurements were made in connection with the Seismic Detection Program. (W.L.H.)

3773 (BNL-595) NUCLEAR ENGINEERING DEPARTMENT PROGRESS REPORT [FOR] SEPTEMBER 1–DECEMBER 31, 1959. (Brookhaven National Lab., Upton, N. Y.). July 1960. 85p. OTS.

Samarium dissolved in bismuth is adsorbed only to the extent of about 1% on dispersed particles of ThO_2. Dissolved uranium and protactinum are more strongly adsorbed, the amount ranging from 10 to 60%, depending on conditions. Technetium is difficult to extract from bismuth with either a strongly oxidizing salt mixture or with liquid zinc. Only 10 to 20% could be extracted in a single contacting by either extractant. Improved data were obtained on the thermodynamic properties of Th–Bi and Zr–Bi alloys. The electrical conductivity of ThF_4 was measured and found to be almost entirely ionic in nature. Removal of xenon from uranium–bismuth fuel was studied in a single perforated plate tower. It was found possible to remove about 80% of the xenon. In an in-pile experiment, a uranium–bismuth fuel mixture was equilibrated with its steel container at 500°C for 12 days. Subsequent analysis showed that the concentration of Xe^{133} in the bulk of the bismuth was 5×10^{12} atoms/g, while the concentration of this nuclide on the steel surface was 8×10^{13} atoms/cm^2. Measurements of the evaporation rate of Po^{210} from irradiated bismuth were extended to lower temperatures. A number of ThO_2 powders were produced by dissolving $Th(NO_3)_4$ in ether, precipitating $Th(OH)_4$ therefrom with NH_4OH, and then calcining the hydroxide at temperatures varying from 600 to 1000°C. Slurry erosion was studied by rotating impeller tabs at tip speeds between 17.5 and 52.5 ft/sec in several slurry vessels and also by rotating anchored steel tabs at a tip speed of 7.5 ft/sec relative to stationary slurry in glass toroids. On the basis of these tests, no significant difference in their tendencies to produce erosion was indicated between the various powders tested. Heat-transfer coefficients were obtained on three new test elements (circular heaters) in a 19-tube bundle through which mercury flowed turbulently and parallel to the tubes. These elements gave results which were in good agreement, but they fell about 50% below theoretically predicted values. The liquid mixture NO_2–HF dissolves beryllium metal at a reasonable rate and causes reactor-grade graphite to disintegrate. It is almost without effect on ceramic ThO_2 fuel pellets. Addition of about 1% H_2O to NO_2–HF does not seriously increase its corrosion of Monel. During zirconium dissolution and drying of the resulting zirconium salt, corrosion is aggravated. When uranium containing small amounts of plutonium is dissolved in NO_2–HF, the plutonium also goes into solution. The dissolution of uranium in UF_6–BrF_3 mixtures high in UF_6 (>50% UF_6) can be hazardous. The solubility of UF_4 in liquid NbF_5 at 100°C is about 1.2 g uranium/liter. When irradiated ThO_2 is treated with successive portions of NO_2–HF, protactinium is extracted up to about 16% of the total amount in the solid. The solubility of krypton in F-12 was measured at temperatures down to −120 and the plate efficiency for absorption was determined. A flowsheet for processing the Enrico Fermi fuel was successfully tested on a laboratory scale. Copolymers of Nylon styrene and Dacron styrene were prepared and characterized. The mechanism of solid-state polymerization of acrylamide was studied further using kinetic, optical microscopic, and electron spin resonance techniques. Irradiation with γ rays increased o-p H_2 conversion activity of magnesium oxide which was pretreated at 350°C, but this effect decayed rapidly with time. Hot Laboratory: The Dowex-1 × 10 columns used for assaying Sr^{90} contamination in Y^{90} product milked from a Y^{90} "cow" were shown to be useful for 37 assays before the column "breaks." Irradiated calcium phthalocyanine, used as a target for the Szilard-Chalmers production of Ca^{47}, can be dissolved in 30% oleum and reprecipitated with anhydrous acetone. Pure TiF_4 was prepared from titanium and BiF_3 for testing the irradiation and distillation away from Ca^{47}. The ratio of ~14-Mev neutrons inside Li^6D to thermal neutrons outside was found to be 6.6×10^{-5}, which is 35 to 80% of theoretical. Mo^{99} yields improved 17-fold by replacing the NaOH dissolution step with mercury-catalyzed HNO_3. Te^{132} yields have also been improved somewhat by the mercury-catalyzed HNO_3 dissolution. Yield of $Ni^{64}(\alpha,n)Cu^{67}$ reaction is 0.0266 μc Cu^{67} per μamp-hr using the internal α beam of the BNL 60-in. cyclotron. A polarographic determination of uranium in the presence of iron for application to plutonium-containing media was devised. Present analytical method for zirconium in uranium–bismuth was shown to detect only elemental zirconium and not oxidized zirconium. A satisfactory method for analyzing uranium and zirconium in a Br_2-ethyl acetate solution of Zircaloy was found. Geometries of end-window β proportional counters were redetermined, and the phenomenon of "self-scattering" was investigated further. Uranium-bismuth alloy tests were concluded in the pumped loops. The application of a high (150°C) ΔT did not accelerate corrosion in a pumped loop (HVL 1). Severe erosion in the $2\frac{1}{4}$ Cr–1 Mo test section specimens forced the shutdown of HVL 4. The bismuth penetrated through the pipe wall in 190 hr at 550 to 400°C. Further data confirmed the inverse relationship between corrosion severity and carbon content of $2\frac{1}{4}$ Cr–1 Mo steel. Uniformity of ZrN and ZrC films on steels

appears to be improved by restricting the access of the zirconium-bismuth to the surface. Radiation capsule corrosion tests have shown severe attack by inhibited U^{235}–Bi on $2\frac{1}{4}$ Cr–1 Mo, $1\frac{1}{4}$ Cr–$\frac{1}{2}$ Mo steels, carbon steel, and Mo–$\frac{1}{2}$-Ti alloy when the bismuth contained 250 ppm zirconium. Increasing the zirconium to 1000 ppm reduced the attack somewhat. Deposition of the $ThBi_2$ in a circulating loop appears to be lessened by the elimination of particles smaller than 10 μ. Production of fine particles by pump impeller agitation may therefore accelerate deposition. The $ThBi_2$ slurry loop was run at the maximum $\Delta\tau$ obtainable until plugging occurred. Mechanical Engineering: Important design information on shielding was developed on the Brookhaven Beam Research Reactor which determined the thicknesses and compositions of the reactor thermal shield, reactor biological shield, and the primary equipment area shield. An aluminum shroud to surround the core was designed, fabricated, and installed for the critical experiments. Adjustable tangential beam tubes were designed and installed in the intermediate reactor core tank. Preliminary specifications and flow sheets were prepared for a Fuel Element Test Loop which will be used for hydraulic tests on fuel elements for the BBRR. All major accessories for the High Level Metallurgical Cell have been fabricated and installed. The wood mock-up for the High Intensity Source Development Laboratory was put into operation. Machines in this cell were tested and operated, by means of manipulators, under actual operating conditions except for the radiation hazard. A conceptual mechanical design was completed for a 250-Mw(t) Fluidized Solids Fueled Reactor. This design is a variation of a fluidized fuel concept that has been studied at Brookhaven. Conceptual drawings of a number of chemonuclear reactors are being prepared. Three reactor concepts are now under study, based on fuels that would release fission fragment energy to a reactant stream. Conceptual drawings of a reactor using the glass fiber fuel were completed, and work in the other two reactor schemes is now in progress. The evaluation studies concerning chemonuclear systems for nitrogen fixation were broadened to include dust and extended surface type fuels. Studies on direct conversion techniques were continued. (For preceding period see BNL-583.) (W.D.M.)

3774 (CF-60-7-46) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, JULY 1960. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Oct. 27, 1960. 70p. OTS.

A critical review of the literature revealed no experiments on uranyl ion transfer from an aqueous to a tributyl phosphate phase which positively measured the kinetics of the chemical reaction at the interphase. Drawing isorhythmic lines on a three component diagram gives a complex correlation for the compaction of three sizes of glass beads. Neither the use of thoria sols nor high feed solution concentrations of thorium nitrate gave any significant increase in mean particle diameters over those obtained from nitrate solutions of lower concentrations in flame denitration. A hydraulic film resistance has been detected in the anion exchange of uranyl sulfate into Dowex 21K, and chloride elution was found to give a higher apparent uranium diffusion coefficient than nitrate elution. The rate of dissolution of mixed thorium-uranium oxides was determined as a function of the per cent of mixed oxides dissolved. Mixing in tanks packed with boron glass Raschig rings is being continued. The SRE hydraulic dejacketer has been operated successfully with prototype fuel rods. Excessive foaming was encountered when sheared stainless-clad UO_2 was suddenly contacted with boiling 13 M nitric acid. While attempting to shear a prototype Yankee subassembly with Kanigan brazed diffusion bonded joints, a five tube aggregate was formed at one of the two ferrule locations sheared. Of the 91 protective coatings exposed to ionizing radiation from the HRE, 25 of the coatings outside of the shield and 10 coatings inside the shield exhibited satisfactory resistance. HETS values in the acid Thorex flowsheet are reported. Waste calcination of simulated Purex waste in a 7-in.-diameter vessel gave rates slightly higher than predicted by the radial deposition model because of loss of feed due to excess foaming. (For preceding period see CF-60-6-11.) (auth)

3775 (FPRC-1075.1) THE OBSERVATION AND LUMINANCE OF A NUCLEAR EXPLOSION. T. C. D. Whiteside (Gt. Brit. Royal Air Force. Inst. of Aviation Medicine). Mar. 1960. 30p. (AD-239858).

The assessment of dazzle produced by nuclear explosions of various sizes is investigated. This assessment therefore necessitated an experiment to measure the brightness (luminance) of such an explosion and the amount of dazzle associated with it. The results of these experiments in the field are in good agreement with the theoretically derived data as well as with previous experimental work on the amount of dazzle produced by bright flashes. (auth)

3776 (LAMS-2443) PROCEEDINGS OF THE CONFERENCE ON SCIENTIFIC APPLICATIONS OF NUCLEAR EXPLOSIONS HELD JULY 6-8, 1959. G. A. Cowan, comp. Los Alamos Scientific Lab., N. Mex. Sept. 23, 1960. 75p. Contract W-7405-eng-36. OTS.

A meeting was held to discuss various proposals for scientific applications of nuclear explosions. The purpose of the meeting was primarily to help evaluate proposals for such scientific experiments with respect to their intrinsic scientific value and the uniqueness of the requirement in each case for a nuclear explosion as an experimental source. The meeting covered the following topics: nuclear physics, meteorology and upper-atmosphere phenomena, experiments in space, hydrodynamics, neutrino experiments, and solid-state studies. (W.L.H.)

3777 (NP-9428) FIRST REPORT ON THE ACTIVITIES OF THE TURKISH ATOMIC ENERGY COMMISSION, 1957–1960. Turkey, Atomic Energy Commission, Anakara. Sept. 1960. 8p.

Activities are briefly reported in legislation, technical assistance, and training. (T.R.H.)

3778 (ORNL-3015) GAS-COOLED REACTOR PROJECT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1960. Oak Ridge National Lab., Tenn. Nov. 11, 1960. 190p. Contract W-7405-eng-26. OTS.

The relative merits of three proposed methods of control-rod programing for operation of the Experimental Gas Cooled Reactor (EGCR) were evaluated. The three methods were (1) uniform bank operation of all rods, (2) partial or full insertion of a few selected control rods, and (3) full insertion of selected control rods and uniform bank operation of the remaining rods. Calculations were made of the amount of heat that will be deposited in the EGCR control rods. The cases considered conformed with the method of control-rod programing suggested above. Calculations were also made of the γ-ray heat deposition to be expected in the EGCR moderator and other core components. These data provide information needed for deter-

mining the over-all core cooling requirements. The hot-channel factors were determined for the EGCR core both for normal operation and for a channel with an additional 10% heat input. Criteria for the failure of EGCR fuel elements based on excessive temperatures and/or excessive fission-gas release were established. The maximum allowable temperature has been set at 1800°F. Design data based on results of irradiation experiments on UO_2 were applied to EGCR operating conditions, and the UO_2 temperatures and the fission-gas pressure buildup were computed. A calculation of the pressure drop across the six fuel assemblies in the highest power channel gave a maximum value of 9.44 psi. The design of the EGCR control rods was modified to overcome difficulties encountered in attaching the central wire rope to the inside of the rod. The thermal characteristics of the modified rod were calculated in order to determine the effects on cooling requirements. Calculations were also made for determining the effect of the reactor radial-flux gradient on the circumferential variation in rod-cladding temperature and any subsequent rod bowing. Experimental data were obtained for a stress analysis of the EGCR pressure vessel. The channel entrance for the apparatus used in the study of the thermal characteristics of the EGCR fuel cluster was modified in an effort to correct for a flow maldistribution observed in earlier experiments. Circumferential temperature profiles were obtained for all seven tubes at 11 axial positions with the altered inlet configuration; the average Reynolds modulus was 50,500 and the surface heat flux was maintained at 6500 Btu/hr·ft^2. An evaluation was completed of preliminary mass-removal measurements obtained in the study of the role of relative cluster orientation on the heat-transfer distribution in an EGCR fuel cluster. Mapping of the isothermal velocity field in the EGCR cluster was concentrated on the effect of relative cluster orientation on the velocities 0.05 in. from the rod surface at four axial levels. The measurements were restricted to a 120° sector of the channel, embracing four rods. Materials Development: Work was continued in the development of a process for recovery of UO_2 by the nitrate-recycle process. Specimen pellets of UO_2 of two different grain sizes have been fabricated for use in prototype irradiation experiments. Thin plates of UO_2 and ThO_2 were prepared for fission-gas-release experiments. The release-rate parameter for the release of Xe^{133} was determined for additional grades of UO_2, including a specimen of fused oxide. Processes are being developed for the preparation of fueled graphite bodies. Graphite fueled with UC by an admixture method and fabricated into cylindrical shapes showed laminations and surface bumps due to partial oxidation of the UC during firing. The rate constants for the reaction of −60 +80-mesh UO_2 with graphite at reduced pressures were determined to be 0.18 at 1275°C and 0.44 at 1375°C. Results indicated that the reaction rate is sensitive to particle size below about 1325°C and relatively insensitive above this temperature. The elastic moduli of AGOT graphite were determined by the sonic method. On a specimen from a block prepared with needle coke, the Young's modulus was essentially constant over the temperature range from 75 to 1000°F. Spectrographic analyses of BeO containing about 200 ppm of lithium indicate that lithium is not evolved from BeO at 850°C. The reactivity of the BeO was measured in a critical assembly before and after heating. Procedures are being developed for producing stainless-steel-clad, hot-swaged rods containing UO_2 for irradiation tests. Densities as high as 94% of theoretical were achieved in the UO_2 in rods swaged at 800°C. Additional data on the weight gain of stainless steel in helium containing CO and CO_2 impurities showed that the reaction rates are approximately proportional to the square root of time and are not strongly affected by the concentration of CO_2 plus CO. An experimental program for investigating the creep buckling and instantaneous collapse of stainless-steel tubes is being carried out to obtain the information needed for design of the EGCR experimental loops. Specimens being tested at 1200°F at pressures of 400 and 600 psi have shown no evidence of collapse. The critical pressure for instantaneous collapse at 1200°F was determined to be 800 psi. Investigations of the effect of environment on the time to rupture of seamless type 304 stainless-steel tubing showed a definite strengthening effect in atmospheres containing CO. Mechanical-property tests on specimens from a low-carbon heat of AISI type 502 steel having five different heat treatments showed that the creep properties of the material are not affected by the environment and that the ductility is not strongly affected by the thermal history. Studies of the fracture characteristics of specimens of artificial weld-heat-affected zones from ASTM A212, grade B, plate showed that exposure to thermal cycles with a maximum temperature of 2400°F using energy inputs of 150,000 and 200,000 joules/in. caused a reduction in notch toughness. The reactions of molybdenum with CO_2, CO, H_2, H_2O, and CH_4 were predicted from thermodynamic calculations. A series of welding experiments on EGCR fuel-capsule closures showed that the tolerances for positioning of the end cap are not critical but that close contact of the end cap with the fuel column will cause restraint of the closure weld and should be avoided. A commercially available welding torch was modified for use in remote welding of the through tubes for the EGCR loops. Results of studies of the reactions of beryllium with CO_2 over the temperature range from 600 to 720°C showed that the reaction is relatively independent of pressure. One test on the reaction of beryllium with water vapor at 700°C at a pressure of 1×10^{-3} mm Hg showed an even lower reaction rate than in CO_2 at 600°C. In the investigation of the effect of extrusion variables on beryllium tubing, the lowest degree of preferred orientation was found in tubes extruded by the filled-billet method from hot-compacted cores. The evaluation of beryllium tubing from various sources was continued. Testing of Components and Materials: Irradiation in the ORR of the eight group II full-diameter prototype EGCR fuel capsules was completed. Irradiation of eight group III capsules was started in the ORR. Six of these capsules consist of beryllium-clad solid UO_2 pellets, and the remaining two are stainless-steel clad. Additional postirradiation examinations of miniature-capsule experimental assemblies were completed. A small increase in immersion density after irradiation was noted. Variations in grain size were correlated with the temperature gradient during irradiation. Columnar growth and grain reorientation were observed in capsules irradiated at central temperatures of 2700°F or higher. The eight group II capsules removed from the ORR were dismantled. Dimensional measurements showed 0- to 0.008-in. increases in the average diameters of the capsules. Examinations were made of steel specimens containing various amounts of chromium after exposure of 1100°F in a helium atmosphere to which 0.18 vol. % CO had been added. Experimental studies of the degassing behavior of selected grades of graphite were continued. Data on the rate of gas evolution at 600 and 1000°C were collected for the various specimens tested, as well as data on volume and composition of gas evolved at the temperatures of interest. Gas-permeability determinations were made on typical uncoated EGCR fuel-element-sleeve graphite specimens, with and without joints, and on plugs. Measurements of the mutual-diffusion coefficients of argon

and helium in AGOT graphite were made at room temperature, 0°C, and −65°C. A procedure was developed for the measurement of small increments in the concentration of helium in air. Increments of 8 to 400 ppm were measured with a coefficient of variation of 2%. Investigations of the removal of radioactive fission-product gases from coolants and other carrier gases were continued with additional dynamic adsorption measurements on charcoal. A related study of longitudinal diffusion of krypton in adsorbers was made, and the heating effects occurring on pressurization of charcoal traps were studied. Further studies of the large negative drifts obtained with Chromel-P–Alumel thermocouples in stagnant helium at 1000°C indicated that the protection tubes used (quartz or alumina) had no effect on the thermocouple drift. Two helical tungsten-rhenium stainless-steel-sheathed exposed-junction thermocouples were tested for 675 hr at 1100°C in a helium atmosphere. Development of Test Loops and Components: Installation of gas-cooled loop No. 1 in the ORR was essentially completed and shakedown tests are in progress. Design layouts were completed for the 5½-in.-OD through tubes for the EGCR in-pile loops. An evaluation of the axial loads indicated that there would be no problem of buckling. Work continued on the design of loop components, such as the gas filters, the gas heaters, the diversion valves, the leak-detection equipment, the gas-transfer equipment, and the loop coolers. A preliminary study of the proposed hydrogen-cooled in-pile loop indicated the need for extensive study of potential hazards. The hazards study indicated the desirability of lowering the loop performance specifications with respect to operating pressure and test fuel-element power. An out-of-pile test loop is being assembled for testing ORR loop No. 2 components. Preliminary tests of a ceramic-metal heater-lead seal developed for this service were terminated when a helium leakage rate of 10 cm^3/min was noted at 600°F with a pressure difference across the seal of 20 psig. Two regenerative compressor units were installed in the twin-turbine vessel of the GC-ORR loop No. 1. High-temperature thermal- and load-cycling tests of mechanical pipe joints were continued. It was found that 10-in.- and 2½-in.-IPS Conoseal joints will remain leak-tight at the temperatures of interest. (For preceding period see ORNL-2964.) (W.D.M.)

3779 (SC-4470(RR)) INSTRUMENTATION SYSTEMS. Final Report. A. D. Thornbrough, E. S. Ames, and H. L. Hawk. Sandia Corp., Albuquerque, N. Mex. Sept. 1960. 114p. Project COWBOY. OTS.

Supplement to SC-4440(RR).

Detailed information is presented on Project Cowboy instrumentation systems and results. Percentages of instrumentation results that were good are as follows: for velocity, 96; for acceleration, 96; for pressure, 77; for strain, 6.7; for displacement, 100; for temperature, 88; and for earth pressure, 83. Good results totaled 92%. (auth)

3780 (TID-6721) ANNUAL RESEARCH REPORT NO. 2. Massachusetts Inst. of Tech., Cambridge. Lab. of Chemical and Solid-State Physics. July 15, 1960. 63p. OTS.

Detailed descriptions of the various projects in the research program of the Laboratory of Chemical and Solid-State Physics are given. Areas of interest reported on include solid-state and molecular theory, structure of solids by x-ray and neutron diffraction, low-temperature and thermal properties of matter, nuclear magnetic resonance, molecular spectroscopy, interatomic and intermolecular forces, chemical and physical studies of transition metal compounds, electrical and optical properties of thin metal deposits, physical chemistry of macromolecules, physical metallurgy, and mechanical properties of solids. (For preceding period see AD-226422.) (W.D.M.)

3781 (UCRL-5917) EXCAVATION WITH NUCLEAR EXPLOSIVES. Gerald W. Johnson. California. Univ., Livermore. Lawrence Radiation Lab. Nov. 1, 1960. 28p. Contract W-7405-eng-48. OTS.

The practicability of carrying out large-scale excavation projects using nuclear explosives was considered. Results of past experience with both nuclear and chemical explosives were evaluated, and a series of high-explosive experiments was executed. In addition, a series of small explosions will be fired in basalt to obtain cratering data for a competent medium. The Soviet Union has been using massive charges of chemical explosives for excavation purposes for several years and is expanding its activities. The present status of all these experiments is described, and the future program is outlined, including a proposed nuclear-excavation experiment at Cape Thompson. (auth)

3782 (UCRL-6165) USE OF LARGE CAVITIES TO REDUCE SEISMIC WAVES FROM UNDERGROUND EXPLOSIONS. Final Report. Roland F. Herbst, Glenn C. Werth, and Donald L. Springer (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 29, 1960. 60p. Project COWBOY. Contract W-7405-eng-48. OTS.

This report analyzes an experiment designed to test the theory of seismic decoupling of underground explosives proposed by Latter, LeLevier, Martinelli, and McMillan [1959]. The theory calculates the amplitude of a 1.7-kt nuclear explosive in a hole in salt and compares it to the measured value of the 1.7-kt Rainier shot in tuff at the same distance. A decoupling factor of about 300 resulted. The experiment, called Cowboy, was designed to test the decoupling principle by carrying out a series of eight high-explosive shots in two spheres made in a salt dome and nine tamped shots for comparison purposes. The seismic data reported were obtained primarily at 14,000 and 22,000 ft from the shot at frequencies of 10 to 30 cps. A salt-to-salt decoupling factor of 100 was obtained which is consistent with the predicted 300 tuff-to-salt factor. When the sphere was over-driven so that the walls did not move elastically (a condition which violates the theory), decoupling factors of 10 and 30 were measured. The report interprets the seismic data to give the dependenee of decoupling on the various parameters of the experiment. The decoupling deduced from measurements made 80 ft from the shot points is found to be consistent with that deduced from the measurements at 14,000 and 22,000 ft. (auth)

3783 (WT-1708) STRUCTURAL RESPONSE AND PERMANENT DISPLACEMENT MEASUREMENTS. R. H. Sievers, Jr., and A. R. Stacy (Army Engineer Research and Development Labs., Fort Belvoir, Va.). Jan. 1960. 218p. Project 26.7 [of] OPERATION HARDTACK II. OTS.

Measurements and visual observations made during the Hardtack II series of underground shots are used as a basis for the shock-resistant design of protective measures for cavities in rock and qualitative prediction of permanent displacements in rock due to nuclear detonations. Vibration measurements on blast-resistant construction in soil were used in the shock-resistant design. With varying soil cover, the compressive mode predominated in arch structures and a mass of soil apparently acted with the structure that varied in magnitude in inverse fashion with two depths of cover. Underground structural harmonic response theories were in part verified for some structures, al-

though the absence of an appreciable flexural mode in buried arch structures was significant. (auth)

3784 (CEA-tr-A-555) PROBLÈMES CHIMIQUES ET TECHNOLOGIQUES DANS LA MISE EN OEUVRE DE L'ÉNERGIE NUCLÉAIRE. (Chemical and Technological Problems in Applications of Nuclear Energy). K. Winnacker. Translated into French from Chem.-Ingr.-Tech. 31, 301-9(1959). 42p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 7171.

BIOLOGY AND MEDICINE

General and Miscellaneous

3785 (AECL-974) CANADIAN RESEARCH IN RADIATION BIOLOGY AND RELATED FIELDS, 1959-60. E. O. Hughes, comp. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1960. 20p. (AECL).

A list is presented of Canadian investigations during 1959 and 1960 related to the effects of radiation on living organisms. The list includes the names of the chief investigators and the approximate scale of the work in man-years and dollars. (C.H.)

3786 (DASA-1173) RADIANT HEAT SOURCES EMPLOYED IN THERMAL RADIATION STUDIES. Final Report. Jefferson A. Carter (Naval Material Lab., Brooklyn). Jan. 7, 1960. 24p. Lab. Project 5046-2, Part 13. (AD-237555).

A general outline is given of the development of carbon-arc imaging and other high radiant flux sources used to investigate the effects of intense thermal radiation. The first carbon-arc imaging furnace consisted of dual 24-in. signaling searchlight units with paraboloidal reflectors. The arc mechanism was removed from one so that it could be used to collect and refocus the radiant energy. The need for larger exposure areas and less beam convergence resulted in the fabrication of a source employing a 24-in. aluminized ellipsoidal reflector. A mechanism to monitor the thermal pulse received at the specimen was designed and constructed. To study the adequacy of the carbon-arc sources which irradiated only small areas, a wide-area tungsten source was assembled. Two high radiance sources used in laboratory evaluation of retinal burns are described. Sixteen illustrations are included. (M.C.G.)

3787 (DASA-1178) A METHOD FOR CALIBRATING RETINAL-BURN SOURCES. Lab. Project 5046-16, Part 10, Final Report, Technical Objective AW-7. H. Korbel and W. L. Derksen. Naval Material Lab., Brooklyn. Mar. 15, 1960. 9p. (AD-239868).

A method is described for measuring the irradiance distribution on the retina of a whole eye which a given retinal-burn source will provide. The method consists of locating at the eye position a lens whose aperture is equal in size to the pupil of the eye and then exploring the image at a certain distance behind the lens. (auth)

3788 (HW-65500) HANFORD BIOLOGY RESEARCH ANNUAL REPORT FOR 1959. D. E. Warner, ed. General Electric Co. Hanford Atomic Products Operation, Richland, Wash. Jan. 15, 1960. 205p. Contract AT(45-1)-1350. OTS.

Separate abstracts have been prepared on 37 sections of this report. A list is included of publications and papers presented at formal meetings during the period. (C.H.)

3789 (HW-65500(p.14-22)) STRONTIUM–CALCIUM INTERRELATIONSHIPS IN THE MATURE AND GROWING RAT. R. F. Palmer and R. C. Thompson. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

A clear difference in physiological treatment of Sr^{90} and Ca^{45} by mature and growing rats was noted. As compared with strontium, a greater fraction of calcium is contained in body components of long biological half life. (auth)

3790 (HW-65500(p.23-9)) COMPARATIVE UPTAKE AND UTILIZATION OF CALCIUM AND Sr^{90} IN EWES AND SUCKLING LAMBS. W. J. Clarke, J. R. McKenney, and V. G. Horstman. General Electric Co. Hanford Atomic Products Operations, Richland, Wash.

A threefold increase in the dietary level of calcium of ewes with suckling lambs resulted in a two to threefold decrease in the amount of Ca^{45} absorbed as compared to less than a twofold decrease in the absorption of Sr^{90}. A lack of discrimination by lambs between the two radionuclides was evident. The concentration factors of calcium in milk and urine were 20 and 0.25 to 0.70 times serum as compared to concentrations factors of 8 to 10 and 4 to 12 times serum for Sr^{90} in milk and urine, respectively. (auth)

3791 (HW-65500(p.30-3)) STRONTIUM–CALCIUM RELATIONSHIPS IN PLANTS. R. L. Uhler. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Uptake of strontium was studied in nutrient solutions in which calcium ranged from excess to deficiency. In the low calcium range the presence of $Sr(NO_3)_2$ alleviated chlorosis associated with calcium deficiency but did not affect other deficiency symptoms. Uptake of strontium in leaves was identical to calcium. Differential retention of strontium over calcium was found in roots and stems at low ratios of strontium to calcium in the substrate. (auth)

3792 (HW-65500(p.34-6)) POTASSIUM, CESIUM-137, AND RUBIDIUM-86 RELATIONSHIPS IN PLANTS AND SOIL. J. F. Cline. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Addition of potassium to the nutrient substrate reduced Cs^{137} and Rb^{86} uptake by plants, but less than expected from an assumed physiological equivalence of the ions. Discrimination between Cs^{137}-K or Rb^{86}-K varied with the concentration of potassium in the substrate. Cesium-137 was not moved appreciably through soil columns by water. Fifty per cent was leached from acid soil columns with 0.1 N KCl, but none was removed from alkaline soil. Flooding did not increase Cs^{137} uptake by rice plants over that observed when soil was not flooded. (auth)

3793 (HW-65500(p.37-41)) INFLUENCE OF SOIL MOISTURE ON ION UPTAKE BY BEAN PLANTS. J. D. Stewart. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Variation in available soil water did not influence plant uptake of Ca^{45} and Sr^{85} but were found to influence Cs^{137} and potassium uptake. Cesium-137 uptake was increased to a greater extent than potassium at the lower moisture levels. Both potassium and Cs^{137} were concentrated more in stems than in leaves as available soil moisture decreased, suggesting reduced translocation to the leaves or translocation from the leaves to the stems. (auth)

3794 (HW-65500(p.42-8)) INSOLUBILITY AS A FACTOR IN Sr^{90} AVAILABILITY TO PLANTS. R. L. Uhler. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

The uptake of Sr^{90} from compounds of varying solubility which were mixed in soils was followed over an extended period. Differences in uptake suggests that Sr^{90} in the presence of phosphate and calcium carbonate are fixed in the formation of hydroxyapatite. Massive applications of phosphate to a calcareous soil contaminated with soluble Sr^{90} reduced Sr^{90} uptake and supports hydroxyapatite fixation of Sr^{90}. (auth)

3795 (HW-65500(p.56-8)) EFFECTS OF INTRAMUSCULAR INJECTIONS OF $Sr^{90}-Y^{90}$ ON RAINBOW TROUT. R. H. Schiffman. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Fish intramuscularly injected twice a week with up to 1.5×10^{-2} μc Sr^{90}-Y^{90}/g of body weight gave no evidence of growth response or effect on mortality, however, weight variability in the medium and high levels of injection did increase. There was no pathological evidence of damage to the gastrointestinal tract. (auth)

3796 (HW-65500(p.59-67)) ANATOMICAL AND PHYSIOLOGICAL DATA IN MINIATURE SWINE. V. G. Horstman, W. J. Clarke, P. L. Hackett, M. E. Kerr, R. L. Persing, and L. K. Bustad. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Summary physiological and anatomical data on miniature swine are presented and, where applicable, compared to that on man. Most of the data in this report are based on the Pitman-Moore strain of miniature swine. Progress on development of a strain of blond miniature swine is included. (auth)

3797 (HW-65500(p.72-3)) REMOVING PLUTONIUM INJECTED IN SKIN OF SWINE. R. L. Persing, V. G. Horstman, and L. K. Bustad. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Following intradermal administration of varying doses of plutonium(IV) nitrate in swine, a lower retention (probably due to sloughing) was observed with high levels than with low levels. Suction cups applied to plutonium-contaminated puncture wounds were ineffective in removal of the contamination. Preliminary observations indicate that tourniquets may aid in restricting translocation of plutonium from contaminated sites. (auth)

3798 (HW-65500(p.78-81)) EFFECTIVENESS OF DTPA IN REMOVING PLUTONIUM FROM THE SWINE. J. E. Ballou and V. H. Smith. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

A single prompt treatment with diethylenetriaminepentaacetate resulted in the excretion of approximately 90% of intravenously injected plutonium. Retention in the skeleton was reduced by a factor of ten. Treatment with DTPA over a period of five days resulted in the removal of 11 to 19% of the plutonium deposited two months prior to the commencement of DTPA treatment. (auth)

3799 (HW-65500(p.85-90)) I^{131} REMOVAL FROM LEAVES. F. P. Hungate, J. D. Stewart, R. L. Uhler, and J. F. Cline. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

The relative efficiencies of various agents in decontaminating leaves exposed to air-borne products from a melted fuel element are reported. (auth)

3800 (HW-65500(p.91-3)) PRELIMINARY OBSERVATIONS ON P^{32} METABOLISM IN MICE. L. K. Bustad, J. E. West, R. L. Persing, and J. R. McKelney. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Preliminary observations are given on the metabolism of radiophosphorus in mice following administration of the isotope by single and chronic oral feeding in drinking water and by single intraperitoneal injection. The bremsstrahlung from the P^{32} deposited in the mice was effectively monitored by using a whole-body mouse counter equipped with thin sodium iodide crystals and aluminum β shields. About 60 per cent of the P^{32} fed orally was absorbed from the gastrointestinal tract. Two weeks following a single intraperitoneal injection the body burden was only 10% of the administered dose. (auth)

3801 (HW-65500(p.94-8)) EFFECT OF MODE OF ADMINISTERING P^{32} TO FISH. P. A. Olson and R. F. Foster. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Continuous addition of P^{32} to the water of aquaria containing cichlids resulted in very inconsistent concentrations of P^{32} in the fish. On the other hand, reasonably consistent concentrations in the fish were achieved from ad libitum feeding of food that contained the isotope. (auth)

3802 (HW-65500(p.99-101)) METABOLISM OF Zn^{65} IN THE RAT. J. E. Ballou. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Studies of the effect of age on Zn^{65} absorption and distribution are presented, together with some observations on the transfer of orally ingested Zn^{65} to the fetuses of pregnant rats. Absorption of Zn^{65} is markedly enhanced in the very young rat. (auth)

3803 (HW-65500(p.102-9)) METABOLISM AND DOSIMETRY OF Zn^{65} IN RAMS. J. R. McKenney, R. O. McClellan, F. L. Rising, W. C. Roesch, and L. K. Bustad. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Between 10 and 20% of ingested Zn^{65} was absorbed from the gastrointestinal tract of rams. Zinc-65 turnover varied from 10 to 30% per day in most tissues to less than 2% in bone and voluntary muscle. With chronic administration, the radiation dose to the gonads would approach 50% of that in the tissues of major concentration (liver, voluntary muscle, and possibly bone) because of external γ contribution from Zn^{65} in thigh muscle. (auth)

3804 (HW-65500(p.110-15)) EFFECTS OF $Sr^{90}SO_4$ INHALATION ON MICE. W. J. Bair and P. L. Hackett. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

After single or daily exposure of mice to $Sr^{90}SO_4$ aerosol, about 70% of the total body burden of $Sr^{90}-Y^{90}$ was contained in the skeleton, 12 to 28% in the skin, less than 1% in the lungs, and about 5% in all other tissues. The biological half life for retention of $Sr^{90}-Y^{90}$ was 25 days after a single exposure and 75 days after daily exposures for six months. Only minor hematological changes were observed in mice with body burdens varying from 0.004 to 3.5 μc. (auth)

3805 (HW-65500(p.116-21)) EXCRETION AND TRANSLOCATION OF $Pu^{239}O_2$ AFTER INHALATION. W. J. Bair, D. H. Willard, and B. J. McClanahan. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

More than 70% of plutonium deposited in dogs by inhalation of plutonium dioxide was found in the lungs immediately after exposure. The half time for whole-body retention of plutonium was about 1800 days during the period from about 10 to 40 weeks after exposure. Translocation of plutonium from the lung to tracheobronchial lymph nodes

was a major pulmonary clearance process. Large variations in daily excretion of plutonium in urine and feces were demonstrated. (auth)

3806 (HW-65500(p.161-4)) A TECHNIQUE FOR MEASURING MOVEMENT OF ISOTOPES ACROSS GILL MEMBRANES. R. H. Schiffman. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

A method of perfusing the gill of a teleost fish is described. Using this method to determine the influx and outflux rates of Sr^{85} showed them to be 1.3×10^{-5} cm/sec and 5.2×10^{-8} cm/sec, respectively. These rates indicate an outflux of Sr^{+2} will occur against a concentration gradient. (auth)

3807 (HW-65500(p.165-8)) COMBINATION ACTIVITY-WORK CAGE FOR MICE. L. K. Bustad and L. D. Carlson. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

A new type of work cage is described that consists of a long wire tube mounted at a steep slope. The food is placed at the bottom of the cage and the source of water is at the top. The number of excursions made by the mouse is determined by a photocell or by a spring-mounted platform activating a coin microswitch and is recorded electrically. (auth)

3808 (HW-65500(p.169-70)) TECHNIQUES FOR STUDYING AEROSOL INHALATION. R. A. Hennacy. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Techniques that can be used to evaluate some of the physiological variables during and after inhalation have been investigated. A thermistor flow meter and a method for introducing aerosols under controlled respiratory conditions were developed. (auth)

3809 (HW-65500(p.171-9)) RADIOACTIVE CONTAMINATION IN WILDLIFE–1959. W. C. Hanson and D. G. Watson. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Concentrations of radioisotopes in the tissues of jack rabbits and shiners, the indicator organisms, and in ducks, whitefish, and deer, the important game species, collected from the Hanford Reservation in 1959, are presented. Values are generally lower than those observed in 1958. Factors responsible for this decrease are discussed. (auth)

3810 (HW-65500(p.180-2)) CHINOOK SALMON SPAWNING IN THE VICINITY OF HANFORD–1959. D. G. Watson. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Chinook salmon spawning in the Columbia River for 1959 was approximately 19% of the 1958 value. High river levels reduced the effectiveness of nest enumeration. There were indications that delay of upstream migration by Priest Rapids Dam added to the numbers of fish spawning near Midway. (auth)

3811 (HW-65500(p.183-7)) ZINC-65 IN MARINE MOLLUSKS NEAR THE MOUTH OF THE COLUMBIA RIVER. D. G. Watson, J. J. Davis, and W. C. Hanson. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Levels of Zn^{65} in mollusks from the Columbia River in 1957 and 1959 are presented together with possible factors responsible for interspecies and seasonal changes in concentration. (auth)

3812 (HW-65500(p.188-93)) MUTATION AND TEMPERATURE EFFECTS IN C. COLUMNARIS. M. P. Fujihara, P. A. Olson, and R. F. Foster. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Mutation rate in C. columnaris was found to be comparable with that in many other haploid bacteria. Survival of young salmon following exposure to water containing the organism was inversely related to the concentration of organisms, the length of exposure, and temperature. C.-columnaris suspended in river water survived several days. (auth)

3813 (HW-65500(p.194-7)) PARTICIPATION IN ENVIRONMENTAL PROGRAM OF PROJECT CHARIOT. J. J. Davis, W. C. Hanson, and D. G. Watson. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Hanford's participation in the Project Chariot Environmental Program includes studies on limnology of streams and ponds, ecology of terrestrial invertebrates, and radioecology of terrestrial and fresh-water communities. The preshot phase of these studies was initiated during the summer of 1959 and will be continued through 1960. (auth)

3814 (ORNL-2997) BIOLOGY DIVISION SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING AUGUST 15, 1960. Oak Ridge National Lab., Tenn. Oct. 17, 1960. 208p. Contract W-7405-eng-26. OTS.

Separate abstracts were prepared on 15 sections of this report. A list is included of publications and lectures during the period. (For preceding period see ORNL-2913.) (C.H.)

3815 (ORNL-2997(p.155-8)) NUCLEIC ACID CHEMISTRY. W. E. Cohn, F. J. Bollum, et al. Oak Ridge National Lab., Tenn.

The role of free pseudouridine 5′-phosphate as a precursor nucleotide for desoxyribonucleic acid was investigated with the aid of a tritium-labeled pseudouridine. Progress is reported in experiments to characterize more fully periodate-oxidized nucleoside 5′-phosphates. Studies on the replication of desoxynucleic acid (DNA) by a purified enzyme system from calf thymus gave evidence that DNA duplication occurred in the entire enzyme system. (C.H.)

3816 (ORNL-2997(p.159-63)) NUCLEIC ACID ENZYMOLOGY. E. Volkin, L. Astrachan, et al. Oak Ridge National Lab., Tenn.

Progress is reported in studies on protein synthesis. Topics discussed include the function of desoxyribonucleic acid in phage-infected bacteria and results of studies on the resemblance of ribonucleic acid and desoxyribonucleic acid in phage-infected and noninfected bacteria. (C.H.)

3817 (ORNL-2997(p.167-87)) ENZYMOLOGY. G. D. Novelli, K. B. Jacobson, et al. Oak Ridge National Lab., Tenn.

Progress is reported in various studies on enzyme activity. Topics discussed include the cell-free synthesis of β-galactosidase; studies on the glucocorticoid-requiring activation of tyrosine-α-ketoglutarate transaminase; studies on an amino-acid-incorporating system from mouse liver; amino acid incorporation into particles isolated from maize seedlings; studies on amino acid incorporation in developing maize kernels; studies on the pathway of sulfate reduction in various microorganisms; the oxidation of thiosulfate by extracts of Thiobacillus thioparus; demonstration of the reversibility of adenosine 5′-phosphosulfate reduction in Desulfovibrio desulfuricans and Thiobacillus thioparus; acetylation reactions in higher animals; studies on the mechanism of glycogen synthesis and breakdown in Tetrahymena pyriformis; enzymes in-

volved in starch biosynthesis in maize; polysaccharide synthesis by a soil diphtheroid; the properties of substances producing histological changes in spleens of lethally irradiated mice; and studies on antibody synthesis. (C.H.)

3818 (ORNL-2997(p.188-91)) MICROBIOLOGY. S. F. Carson, R. K. Clayton, et al. Oak Ridge National Lab., Tenn.

Progress is reported in enzyme and tracer studies on bacterial metabolism; carotenoids and photooxidative killing and the identification of high-catalase mutants of Rhodopseudomonas spheroides; carotenoid biosynthesis and carotenoid-bacteriochlorophyll interactions; a study of the properties of a cobamide coenzyme of Propionibacterium pentosaceum; and tracer studies on the synthesis of methylmalonate. (C.H.)

3819 (ORNL-2997(p.192-6)) PLANT PHYSIOLOGY AND PHOTOSYNTHESIS. A. H. Haber, D. E. Foard, et al. Oak Ridge National Lab., Tenn.

Progress is reported in studies on the action of maleic hydrazide on dormancy, cell division, and cell expansion in lettuce seed; the action of 6-(substituted) purines on mitotic activity in dormant lettuce seeds; and studies of the first step in photosynthesis, involving the interaction of light quanta with electrons, using chromatophores of photosynthetic bacteria. (C.H.)

3820 (ORNL-2997(p.197-202)) BIOPHYSICS. J. S. Kirby-Smith, J. Jagger, et al. Oak Ridge National Lab., Tenn.

Progress is reported in studies on the induction of chromosome aberrations in Tradescantia pollen by combined x-ray and ultraviolet treatment; the use of ultraviolet radiation in the modification of the frequency of recessive lethals induced by x rays in Drosophila; and the production and decay of free radicals induced by x radiation in dry lettuce seed. (C.H.)

3821 (TID-6056) SHOCK TUBE STUDIES OF THE EFFECTS OF SHARP-RISING, LONG-DURATION OVERPRESSURES ON BIOLOGICAL SYSTEMS. Progress Report. D. R. Richmond, R. V. Taborelli, F. Sherping, M. B. Wetherbe, R. T. Sanchez, V. C. Goldizen, and C. S. White (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Mar. 10, 1959. 31p. Contract AT(29-1)-1242. OTS.

Presented at the Third Shock Tube Symposium, Fort Monroe, Virginia, March 9-11, 1959.

A closed-end shock tube was used to study the effects of single and step-wise, fast-rising overpressures of long duration on mice, rats, guinea pigs, and rabbits. For animals exposed side-on against the end-plate to single, sharp-rising pressure pulses, the reflected pressures necessary to kill 50 per cent (LD_{50}) were as follows: for the mouse -29.8 ± 1.1; rabbit -33.4 ± 1.2; guinea pig -36.7 ± 0.7; and the rat -38.7 ± 0.6 psi. Animals located at short distances away from the end-plate were loaded in a two-step manner. The steps corresponded to the incident and reflected shock fronts. With stepwise increases in pressure, animals tolerated much higher reflected overpressures than when the pressure load consisted of a single, sharp-rising pulse. The importance of the time interval between step loads was pointed out and briefly discussed. (auth)

3822 (UCSF-20) PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1960. California. Univ., San Francisco. School of Medicine. Radiological Lab. Sept. 1960. 58p. Project No. 2. Contract AT-11-1-GEN-10. OTS.

Between July 1956 and the end of July 1960 154 patients with carcinoma were treated with 70-Mv x rays from the synchrotron. Mortality and survival data on these patients are tabulated. Activities of the personnel engaged in the development, calibration, maintenance, and operation of the 70-Mev synchrotron are summarized. Progress is reported in various studies pertaining to radiation injury and recovery. Topics discussed include the prompt and acute effects of x rays on bone marrow; the response of mouse femoral bone marrow to whole-body x-radiation exposure; the syndrome of radiation injuries in the Chinese hamster; studies on the latent period of x-ray-induced life shortening in mice; the pathology of progressive intercapillary glomerulosclerosis in the mouse, rat, and hamster associated with aging and radiation exposure; the effect of age on epithelial-cell renewal in the mouse intestine; the influence of age at exposure on the late effects of x rays in mice; studies of life shortening in man after radiation therapy; and studies on the life span of the progeny of x-irradiated male mice. A list is included of publications and papers issued during the period. (C.H.)

3823 (USNRDL-TR-448) FLUX AND SPECTRUM OF SIMULATED FISSION NEUTRONS IN THE VICINITY OF AN OPENING IN A NEUTRON SHIELD. E. Tochilin and B. W. Shumway. Naval Radiological Defense Lab., San Francisco. July 19, 1960. 27p.

Neutron dosimetry is discussed relative to an exposure facility for partial-body irradiation studies. The assembly consists of a 3-section shield composed of lead, boron, and paraffin. Presence of the partial-body shield increased the neutron dose in the exposure region by about 16%. (C.J.G.)

3824 (JPRS-5381) BASIC PRINCIPLES OF THE ORGANIZATION OF RADIOLOGIC SERVICE IN VARIOUS THERAPEUTIC INSTITUTIONS. A. V. Kozlova and T. S. Seletskaya. Translated from Vestnik Rentgenol. i Radiol. 35, No. 2, 52-8(1960). 10p. OTS.

Clinical applications of radioisotopes in diagnosis and therapy are reviewed. Special safeguards and equipment of the radiologic service in therapeutic departments are discussed. (C.H.)

3825 (JPRS-7054) EVALUATION OF THE IRRADIATION REACTION OF THE ORGANISM IN THE DETERMINATION OF THE DOSE ABSORBED IN INTEGRAL UNITS. (Otsenka Luchevoy Reaktsii Organizma pri Opredelenii Pogloshchennoy Dozy v Integral'nykh Yedinitsakh). E. (Ye.) V. Utekhin. Translated from Vestnik Rentgenol. i Radiol. 35, No. 4, 48-50(1960). 5p. OTS.

Irradiation reaction data are correlated with the patient's weight to show that the weight must be included in absorbed-dose considerations. In dose calculations it is suggested that a conversion to total human body weight be made (gram-rads per kg). When body weight is doubled, the dose absorbed in an irradiated volume, relative to the unit of body weight, increases approximately $1\frac{1}{2}$ times. (T.R.H.)

3826 STUDIES IN QUANTITATIVE RADIOBIOLOGY. Karl Günter Zimmer. Abhandl. Akad. Wiss. u. Lit. Mainz. Math.-naturw. Kl., No. 3, 111-217(1960). (In German). (KFK-27).

A review is presented beginning with a short historical survey covering basic observations and direct interaction hypotheses. The discussion is extended to general-formal hit theory, hit-region theory, and theory of interaction by means of diffusible agents. The last section is devoted to tools for further development, such as microwave spectroscopy and free-radical studies. (About 400 references). (T.R.H.)

3827 STUDIES RELEVANT TO SLOW NEUTRON CAPTURE THERAPY OF BRAIN TUMOR. William H. Sweet, Albert H. Soloway, and Gordon L. Brownell (Massachusetts General Hospital, Boston). Acta Unio Intern contra Cancrum 16, 1216-19(1960).

In the search for a boron-containing substance which would concentrate much more in gliomas than in brain, phenylboronic acid and seven mono-substituted compounds thereof were studied. For each compound the partitioning ratio between an aqueous medium and benzene, the toxicity in mice, and the glioma to brain ratio in mice following parenteral injection were measured. Increasing aqueous to benzene concentration was correlated with increased glioma to brain ratio and decreasing toxicity. P-tolylboronic acid and p-chlorophenylboronic acid concentrated least in water and glioma respectively and were the most toxic. Phenylboronic acid itself and its p-methoxy and o-nitro compounds were intermediate in these respects, whereas carboxyl or carbamido substituents yielded the least toxicity and the greatest differential concentration in glioma. P-carboxyphenylboronic acid shows more favorable glioma to brain ratios in mice than does tri-isopropanolamine borate which in turn is more favorable than borax. Tri-isopropanolamine borate in biopsy analyses in man yields higher differential concentrations regarding brain in the meningiomas and neurinomas than in the glioblastomas. Boron slow-neutron-capture therapy of intracranial tumors in man will be carried out in a surgical operating room beneath the nuclear reactor at the Massachusetts Institute of Technology. Here a maximal flux of slow neutrons will be directed at the exposed cut face of brain remaining following resection of glioma plus brain some weeks earlier. (auth)

3828 TRANSAMINATION OF CYSTEINESULFINIC ACID BY EXTRACTS OF OAT LEAVES. H. Pérez-Milan, J. Schliack, and P. Fromageot (Centre d'Etudes Nucléaires, Saclay, France). Biochem. et Biophys. Acta 36, 73-83 (1959). (In French) (CEA-1405)

An aqueous extract of oat leaves catalyzes a transamination between cysteine-sulfinic acid and α-ketoglutaric acid. Under the conditions utilized pyruvic acid is not an acceptor of the amino group. Neither cysteic nor aspartic acid is a substrate for the transaminase of cysteinesulfinic acid. (auth)

3829 THYROID UPTAKES BY HUMAN BEINGS FOLLOWING ORAL ADMINISTRATION OF DIFFERENT I^{131} PREPARATIONS. V. M. Doctor, R. G. Rose, and W. C. Dewey (Univ. of Texas, Houston). Endocrinology 67, 875-7 (1960) Dec.

The extraneous band solutions were obtained from one- to two-week-old NaI^{131} solutions by paper chromatographic separation and elution procedure. Fresh solutions of NaI^{131} which contain over .0% of the radioactivity in the NaI^{131} band were used for studies with NaI^{131}. Effect of pH 3.0 on the stability of the NaI^{131} solutions and of the extraneous band solutions was studied. The results show that, at pH 3.0, about 90% of the extraneous band is converted to NaI^{131} band within 10 min. Studies on the uptake of orally administered NaI^{131} solution or the extraneous band solution by human thyroid glands indicate the same uptake of the NaI^{131} solution as compared to the extraneous band solution. (auth)

3830 QUANTITATIVE DETERMINATION OF THE MINERAL CONTENT OF BONES FROM X-RAY PICTURES. F. Heuck and E. Schmidt (Medizinische Universitätsklinik, Kiel). Fortschr. Gebiete Röntgenstrahlen u. Nuklearmed. 93, 523-54(1960) Nov. (In German)

The theoretical principles are discussed of a method of determining the concentration of bone mineral per unit volume bone tissue. In this connection the problems of absorption and scattering of x rays in mixtures of substances are emphasized as well as the elimination of errors that arise from the organic material in bones, the processing of the film, and film photometry. The comparison standard used consists of hydroxylapatite and plastic; it is always exactly reproducible; its chemical composition is very similar to that of bone and it is thus equivalent to bone in its physical behavior to x rays. By comparing the photometric results obtained from radiographs with those of the chemical analysis of the mineral content per volume bone tissue (determination of the "apatite" value), a maximum deviation of the obtained values of ±10% was established (methodical error). Besides the discussion of the apatite values obtained from radiographs and the results of chemical determinations of the mineral content of healthy and morbid bones, the deviations of mineral content on cases of osteopathy are presented. (auth)

3831 THE UPTAKE AND ELIMINATION OF CESIUM-137 BY A GRASSHOPPER—ROMALEA MICROPTERA. D. A. Crossley, Jr. (Oak Ridge National Lab., Tenn.) and M. E. Pryor. Health Phys. 4, 16-20(1960) Oct.

Adults of Romalea microptera, the eastern lubber grasshopper, were fed cesium-137 in bean plants to investigate uptake and elimination of this isotope. A biological half-life of 4 to 5 days was obtained. In experiments where grasshoppers were allowed to feed repeatedly on cesium-contaminated food, the biological half-life was used to predict the equilibrium values. Most of the ingested Cs^{137} was concentrated in muscular tissue, but some was also found in the digestive tract and reproductive organs. Only trace amounts were found in the exoskeleton. (auth)

3832 EVALUATION OF TWO BORON-CONTAINING DRUGS FOR USE IN THE PROPOSED NEUTRON-CAPTURE IRRADIATION OF GLIOMAS. A. H. Soloway and D. S. Gordon (Massachusetts General Hospital, Boston). J. Neuropathol. Exptl. Neurol. 19, 415-20(1960) July.

A study was conducted for the evaluation of boron compounds toward the utilization of neutron-capture irradiation in the treatment of gliomas. Two drugs, p-carboxyphenylboronic acid and triisopropanolamine borate, were tested toxicologically in animals and man and compared with boric acid. Their excretion pattern was followed in a series of eight patients, some of whom received multiple doses. Both compounds were rapidly excreted by the kidney, and, like boric acid, they behave as low-threshold substances. Consequently, thermal-neutron therapy could be reinsti[illegible] in a week's time since the normal brain boron content then would be vanishingly small. The high boron content of the pituitary presents a possible method for performing a nonsurgical hypophysectomy without concomitant damage to adjacent nervous tissue. (auth)

3833 PENETRATION OF BRAIN AND BRAIN TUMOR BY AROMATIC COMPOUNDS AS A FUNCTION OF MOLECULAR SUBSTITUENTS. A. H. Soloway, B. Whitman, and J. R. Messer (Massachusetts General Hospital, and Harvard Medical School, Boston). J. Pharmacol. Exptl. Therap. 129, 310-14(1960) July.

A correlation is made between aqueous-benzene partition coefficients of a series of substituted phenylboronic acids

and tumor/brain ratios of these compounds in mice having subcutaneously transplanted gliomas. Those substances which concentrate preferentially in the benzene phase invariably penetrated normal brain more readily than tumor and were quite toxic to the CNS. The converse proposition, however, is not always true, but compounds which did give good tumor/brain ratios were only found in the hydrophilic group. In general it would appear that lipid solubility of a compound is an important factor, but certainly not the only one, in determining the penetration of the brain. (auth)

3834 THE RE-ESTABLISHMENT IN DOGS OF THE BLOOD-BRAIN BARRIER TO TRI-ISOPROPANOLAMINE BORATE. A. H. Soloway, J. G. de Rougemont, and W. H. Sweet (Massachusetts General Hospital, Boston and Harvard Univ., Boston). Neurochir. 3, No. 1, 5p.(1960) July. (In English)

The recovery of the blood-brain barrier in dogs that have been subjected to surgical trauma has been studied by determining the penetration of tri-isopropanolamine borate into traumatized brain. Recovery of normal permeability occurred by the third week after surgery. This would be the time when neutron capture irradiation of any residual neoplastic cells could be instituted, if we assume a similar rate of recovery in the gliomatous brain of man. (auth)

3835 RELATION OF AGE TO RADIOMAGNESIUM EXCHANGE IN BONE. Sidney Breibart, Johng Sup Lee, Augusta McCoord, and Gilbert B. Forbes (Univ. of Rochester, N. Y.). Proc. Soc. Exptl. Biol. Med. 105, 361-3(1960) Nov.

In the rat, the exchange of Mg^{28} in cortical bone occurs much more rapidly in young animals than in old. The stable magnesium content of bone increases with age and varies inversely with bone-water content. A method for separating Mg from Ca and P by cation-exchange chromatography is described. (auth)

3836 APPLICATIONS OF COMPENSATION FOILS. Rüdiger Seyss (Röntgenabteilung des a. ö. Krankenhauses, Neunkirchen, Ger.). Röntgen Bl. 13, 47-8(1960) Feb. (In German)

The use of compensation foils in x-ray diagnostics of chest, abdomen, head, and skeleton is briefly surveyed. (T.R.H.)

3837 DETERMINATION OF LAYER THICKNESS WITH SIMULTANEOUS LAYER CASSETTES. Josef Stockhausen and Horst Radke (Röntgenabteilung des St.-Markus-Krankenhauses, Frankfurt am Main). Röntgen Bl. 13, 97-103(1960) Apr. (In German)

A standard model has been constructed, which makes it possible to determine the layer thickness, as well as the distance between the different layer planes in the application of simultaneous multisection laminography. (auth)

3838 NATURAL LEAD-210 CONTENT OF MAN. John B. Hursh (Univ. of Rochester, N. Y.). Science 132, 1666-7(1960) Dec. 2.

The natural Pb^{210} content of ash samples from 18 cadavers has been measured, and an average in vivo content of 0.015 picocurie per gram of wet bone is estimated. The contribution of Pb^{210} to the radioactive dose from natural sources is about one-fifth that from internally deposited Ra^{226} and its daughters. (auth)

3839 THE RADIOISOTOPIC LOCALIZATION OF INTRACRANIAL NEOPLASIA UTILIZING THE FOCUSING COLLIMATOR SCINTILLATION COUNTER WITH PHOTOSCAN ATTACHMENT. David R. Taxdal and John McAfee (Johns Hopkins Univ., Baltimore). Southern Med. J. 53, 418-24(1960) Apr.

The localization of brain tumors by means of the focusing collimator and scintillation counter with photoscan attachment has been graphically presented. Improved instrumentation has resulted in scans of such quality that they may easily be interpreted. This ancillary diagnostic tool is as useful as air studies or arteriography, and it carries none of the mortality or morbidity of either. (auth)

3840 A SURGEON VIEWS RADIOACTIVE IODINE AND THE THYROID PROBLEM. Lindon Seed (Univ. of Illinois, Chicago and Oak Park Hospitals, Chicago). Southern Med. J. 53, 424-9(1960) Apr.

The tracer dose of radioactive iodine is helpful in diagnosis but is not a necessity. The scan will determine if nodules are hot or cold, but since benign nodules are usually cold, it does not constitute a good means of distinguishing benign from malignant nodules. It will occasionally pick up a hot nodule that does not need to be operated on. Its use in determining the size of an exophthalmic goiter is problematical. I^{131} is a better form of therapy than surgery in exophthalmic goiter in adult patients. I^{131} can be used as preoperative and even definitive treatment in elderly patients with toxic nodular goiter in whom surgical mortality is excessive. I^{131} therapy in cancer of the thyroid is disappointing; but, since an occasional patient does respond to such treatment it should be considered in each case. (auth)

3841 THIOLS AND RADIATION DAMAGE. D. B. Hope (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.93-114 of "Glutathione. Biochemical Society Symposium No. 17 held at University of London on 15 February 1958." E. M. Crook, ed. Cambridge, Eng., University Press, 1959.

A review is presented of the protective effects of certain sulfur-containing compounds against radiation damage in tissues. The discussion includes radiosensitivity of cells, radiation chemistry, theories of protective action, irradiation of enzymes, protection of living organisms against radiation damage by S-containing substances, experimental methods, localization and binding of protective thiols to tissue constituents, and Eldjarn's mixed disulfide theory of radiation protection. (About 120 references). (T.R.H.)

Biochemistry, Nutrition, and Toxicology

3842 (HW-65500(p.53-5)) COMPARATIVE TOXICITY OF Sr^{90}, Ra^{226}, AND Pu^{239}, IN MINIATURE SWINE. W. J. Clarke, J. R. McKenney, and V. G. Horstman. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

The design and preliminary results are described for an experiment devised to lend confidence to the extrapolation of Sr^{90} toxicity data from dog to man by means of comparative Sr^{90} and Ra^{226} toxicity studies in miniature swine. The relative toxicity of Pu^{239} in swine as compared to that in dogs is also being investigated. (auth)

3843 (HW-65500(p.122-8)) DISTRIBUTION AND TOXICITY OF INHALED $Pu^{239}O_2$. D. H. Willard. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Adult beagle dogs were exposed to $Pu^{239}O_2$ aerosols of varying concentration and particle size. Between 53 and 63 per cent of the total $Pu^{239}O_2$ deposited was present in the lung for two weeks post exposure. The extremely small quantities found in bone and other organs demonstrated the insolubility of $Pu^{239}O_2$. Other dogs in which 25 to 150 μc $Pu^{239}O_2$ was deposited died within 50 to 75 days. Death was preceded by decreasing total-blood lymphocyte counts and increasing respiratory rate. (auth)

3844 (HW-65500(p.129-38)) BIOLOGICAL EFFECTS OF INHALED $Pu^{239}O_2$ AND $Ru^{106}O_2$ IN MICE. L. A. Temple and W. J. Bair. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

A greater death rate was observed in mice with increasing amounts of inhaled $Pu^{239}O_2$, whereas enlarged lymph nodes and fewer pulmonary adenomatous tumors were seen at necropsy of mice living 500 days after inhalation of either $Pu^{239}O_2$ or $Ru^{106}O_2$. Microsections and autoradiograms of a possible bronchiolar caricinoma and neoplastic tissue in a mesenteric lymph node are described. (auth)

3845 (UCRL-9290) FURTHER STUDIES ON STERILITY PRODUCED IN MALE MICE BY DEUTERIUM OXIDE. Ann M. Hughes, Edward L. Bennett, and Melvin Calvin. California. Univ., Berkeley. Lawrence Radiation Lab. June 1960. 12p. Contract W-7405-eng-48. OTS.

Thirty percent D_2O in the drinking water of male Swiss mice produces sterility. Both a decrease in litter size and a decreased percentage of fertile matings were observed when treated males were mated with normal females. No increase in regressions was obtained. The development of mouse eggs in a female mated with a D_2O-treated male is generally abnormal; few multicelled eggs are obtained 2 to $2\frac{1}{2}$ days after copulation. It is suggested that changes in physical forces that bind macromolecules are produced by the substitution of deuterium for hydrogen. These changes may result in abnormal genetic material in developing sperm. (auth)

Fallout and Ecology

3846 BIOLOGICAL CYCLES OF RADIOACTIVE CONTAMINANTS. M. G. Michon. Rev. pathol. gén. et physiol. clin. No. 707, 505-14(1959) Apr. (In French) (CEA-1273)

Artificial radioelements (synthesized for scientific or industrial purposes) having been released, may be absorbed by plants or animals, and may eventually involve a catenation of organisms as some feed on the others. All organisms living in a polluted river become more radioactive than the water, which was to be expected, inasmuch as organisms are hypertonic with respect to fresh water. Conversely, soil brings into play physicochemical phenomena (absorption) such that plants can get only a small portion of contaminating radioelements, land animal feeding on such plants are relatively less exposed to contamination, and carnivorous animals feeding on herbivorous are still less exposed. Man, notably, is fairly well protected; whereas lower organisms, notably unicellular organisms, may suffer (mutations). (auth)

Radiation Effects on Living Tissues

3847 (AD-235606) DETERMINATION OF RELATIVE RESISTANCE OF SELECTED STRAINS OF CLOSTRIDIUM BOTULINUM TO IONIZING RADIATIONS. Report No. 4 (Progress) [for] Period April 14, 1959–July 13, 1959. Charles T. Townsend. National Canners Assn. Western Research Lab., Berkeley, Calif. 5p. Project No. 7-84-01-002. Contract DA19-129-QM-1184.

Preliminary results are reported from a study on the resistance of several selected strains of Clostridium botulinum to ionizing radiations. (C.H.)

3848 (AD-240430) EFFECT OF X-IRRADIATION ON BLOOD CELLS. Summary Progress Report No. 13 for September 1, 1959–July 31, 1960. Milton A. Lessler (Ohio State Univ. Research Foundation, Columbus). July 1960. 6p. RF Project 513. Contract DA-49-007-MD-293.

Studies of the metabolism of human erythrocytes in autologous plasma, in physiological saline solutions, and those stored under standard blood bank conditions were carried out. A comparison of cellular respiration in plasma and physiological saline indicates that human red cell respiration is greater in plasma by a factor of about 2.5. Fresh or 48-hr stored erythrocytes exposed to 700 r showed decreased respiration when incubated in plasma. In physiological saline, where the respiration level is lower than in plasma, no significant respiratory changes were noted following either 700 or 1400 r. Red cells stored in ACD show depressed respiratory levels and no significant changes from these levels following x-ray doses of 700 or 1400 r. Electron microscope studies of frog red and white cells revealed the presence of mitochondria in thin-sectioned cells. Preparations of x-irradiated (1000 r) blood cells showed gross cytoplasmic abnormalities and disruption of the normal mitochondrial structure. (auth)

3849 (AF-SAM-60-60) EFFECTS OF CHRONIC LOW DOSE NEUTRON IRRADIATION UPON PERIPHERAL BLOOD ELEMENTS IN THE MONKEY (MACACA MULATTA). George B. Melville, Jr., Robert J. Young, Henry Borella, and John E. Pickering (Texas. Univ., Austin. Radiobiological Lab. and School of Aviation Medicine, Brooks AFB, Tex.). Mar. 1, 1960. 14p.

Twenty-four monkeys (Macaca mulatta) were divided into four groups of six and exposed periodically to low doses of neutrons from Po-Be sources. The irradiated groups received 13, 28, and 55 rep total dose, which was divided into doses administered every 4 days for 40 exposures. The cellular elements of the peripheral blood, hemoglobin, and hematocrit values were sampled and enumerated at intervals postirradiation. These data were analyzed by analysis of variance. All surviving monkeys reestablished normal hematologic values by the end of 24 weeks postirradiation. There was no indication of any incapacitating injury under these experimental conditions. A significant statistical result was found for reticulocytes, hematocrit values, neutrophils, and lymphocytes. Only the hematocrit value changes are considered interpretable in terms of the irradiation treatment. (auth)

3850 (HW-65500(p.68-9)) CUTANEOUS FIBROSARCOMA IN A RABBIT FOLLOWING BETA IRRADIATION. L. A. George, II, R. L. Persing, S. Marks, and L. K. Bustad. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

A cutaneous fibrosarcoma with metastases was observed four years after localized beta irradiation of the skin. The gross and microscopic appearance of the primary lesion and its metastases are described. (auth)

3851 (HW-65500(p.70-1)) TREATMENT OF RADIATION LESIONS OF THE SKIN. R. L. Persing and L. K.

Bustad. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Application of a commercial ointment resulted in more rapid healing and less scar formation than two other methods used in treatment of skin lesions following exposure to radiation from a Van de Graaff accelerator. (auth)

3852 (HW-65500(p.74-7)) FETAL HEMATOPOIETIC TISSUE TRANSFUSIONS IN LETHALLY X-IRRADIATED SWINE. W. J. Clarke. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

In a study on the therapeutic effect of either fetal hematopoietic or adult marrow cell transfusions in the prevention of death in lethally x-irradiated (900 r) swine, 1 out of 12 animals survived. (auth)

3853 (HW-65500(p.82-4)) BIOLOGICAL EFFECTS OF I^{131} IN SHEEP AND SWINE. V. G. Horstman, R. L. Persing, S. Marks, P. L. Hackett, and L. K. Bustad. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Thyroid adenomas were observed in two sheep fed 1.5 μc of I^{131} per day during their four-and-one-half-year lifetime (including radioiodine exposure in utero and via the milk during the suckling period). A reduction of approximately 50% in thyroid uptake of a tracer dose of I^{131} in a group of ewes fed a single 3-mc dose indicated that the thyroid was partially damaged. Following a tracer dose of I^{131} to Palouse swine fed 5 μc/day for over three years, a thyroid uptake study showed that swine on high plane of nutrition had a higher thyroid uptake and longer I^{131} effective half life than animals on a low plane of nutrition. No definite evidence of thyroid damage, as revealed by I^{131} uptake, was demonstrated after feeding of 5 μc per day for over three and one-half years. (auth)

3854 (HW-65500(p.139-42)) EFFECT OF GASTROINTESTINAL IRRADIATION ON GLUCOSE ABSORPTION. M. F. Sullivan. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

The rate of absorption of glucose from the intestine of the rat is inhibited by irradiation of the exteriorized intestine. Maximal effects of 50 to 60% inhibition of absorption are noted three days after irradiation. The extent of inhibition and rate of recovery are dose dependent. The effect is prevented at lower dose levels by cysteine administration and is mimicked by administration of nitrogen mustards. (auth)

3855 (HW-65500(p.143-6)) POLYVINYLPYRROLIDONE EXCRETION AS AN INDICATOR OF RADIATION DAMAGE TO THE INTESTINE. M. F. Sullivan. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

The excretion in the feces of intravenously administered I^{131}-labeled polyvinylpyrrolidone was found to be proportional to the irradiation dose to the intestine. (auth)

3856 (HW-65500(p.147-53)) THE EFFECT OF COMBINED PLUTONIUM AND X-IRRADIATION IN THE RAT. J. E. Ballou. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Under conditions of acute administration, the lethal effect of either x irradiation or plutonium administration is markedly increased by their combined application. This enhancement of effect is reduced if the x irradiation is delayed for 14 days following plutonium administration. Survival time of chronically x-irradiated animals (100 r/week) is substantially shortened by a plutonium burden of 5 μc/kg. Depressions in peripheral blood elements were generally more pronounced and prolonged with the combined insult. Distribution and retention of plutonium were unaffected by concurrent x irradiation. (auth)

3857 (HW-65500(p.154-8)) LOSS OF CELLULAR CONSTITUENTS FROM X-IRRADIATED YEAST. R. T. O'Brien. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Leakage from irradiated yeast was shown to be due to diffusion and not an energy requiring process. Ion uptake mechanisms appear to be unaffected by radiation. A reverse-oxygen effect suggests that the mechanism of x-ray damage to the cell wall is different from that affecting viability. (auth)

3858 (HW-65500(p.159-60)) RADIATION SENSITIVITY OF CYTOCHROME DEFICIENT YEAST. R. T. O'Brien. General Electric Co. Hanford Atomic Products Operation, Richland, Wash.

Catalase in respiration deficient yeast affects sensitivity of the cells to x rays. It is concluded that only intracellular peroxide leads to cell death. (auth)

3859 (NYO-9343) PREPARATION OF A SUBSTANCE FOR THE PREVENTION OF VASCULAR DAMAGE DUE TO RADIATION. Final Report. J. Philip Mason and Maurice H. Shulman. Boston Univ. Nov. 1960. 16p. Contract AT-30-1-2242. OTS.

Thermal burns induced in the hamster cheek pouch were treated with 1-methyl-2-iodo-3,5,6-indoletriol, 2-iodooxoadrenochrome, 2-bromoadrenochrome, and one of the melanins. The first three of these compounds seemed to have some beneficial effects, but the melanin did not. Adrenochrome, adrenolutin, 2-iodooxoadrenochrome, 1-methyl-2-iodo-3,5,6-indoletriol, and possibly the melanins derived from the latter two compounds showed some effect in decreasing the number of petechia formed as a result of x irradiation and also showed some effect in decreasing the mortality rate of the hamsters which had been injected with these chemicals. Procedures for the preparation of the chemicals are included. (C.H.)

3860 (ORNL-2997(p.31-62)) CYTOGENETIC EFFECTS OF RADIATION. R. F. Kimball, S. W. Perdue, et al. Oak Ridge National Lab., Tenn.

Progress is reported in studies on the cytogenetic effects of radiation in Paramecium, Spathidia, Tradescantia, Vicia, maize, phage, and Neurospora. Topics discussed include the refractory period for mutation induction in Paramecium aurelia; the long-term effect of ionizing radiation on the micronucleus of Tetrahymena pyriformis; effects of x radiation on Spathidium spathula; the limited number of nuclear sites for chromosome exchange and the distribution of aberrations in Tradescantia; cell death and root growth in irradiated Vicia; desoxyribonucleic acid synthesis and mitosis in Vicia roots; hybrid enzyme formation in maize heterozygotes; electrophoretic studies on maize amylases; the genetic effects of ethyl methane sulfonate exposure in phage T 4; the effects of indole-3-acetic acid on root growth; evidence for complexity in the complementation map of the ad-3 region of Neurospora crassa; the significance of the changes in the complementation patterns of individual ad-3B mutants of Neurospora with time; protection with AET · Br · HBr against the mutagenic and lethal effects of x rays in Neurospora; the genetic relationships of hist-3 mutants of Neurospora; and histidinol dehydrogenase assays of hist-3 mutants of Neurospora. (C.H.)

3861 (ORNL-2997(p.63-76)) CELL GROWTH AND REPRODUCTION. D. M. Prescott, C. H. Shappert, et al. Oak Ridge National Lab., Tenn.

Progress is reported in studies on the effect of radiation on cell growth and reproduction in Tetrahymena, grasshopper embryos, and Drosophila. Topics discussed include ribonucleic acid synthesis in the cell nucleus and transfer of ribonucleic acid from nucleus to cytoplasm in Tetrahymena; the acceleration of mitotic rate by microbeam irradiation of the nucleolus with small doses of ultraviolet radiation; chromosome breaks induced in grasshopper neuroblasts by 3-r x rays; male sterility of translocations between the X chromosome and the major autosomes in Drosophila; the compound generating bar of stone duplications, allelic interactions and dosage effects at the pin locus, and enhancement of the red fat cell phenotype of Drosophila by larvae starvation. (C.H.)

3862 (ORNL-2997(p.77-86)) MAMMALIAN GENETICS AND DEVELOPMENT. E. M. Kelly, L. Wickham, et al. Oak Ridge National Lab., Tenn.

Progress is reported in studies on the effects of radiation on mammalian gametogenesis, development in mice, and the cytogenetic effects of radiation in mammals. Topics discussed include the effects of radiation intensity on mutation frequency; the variegated type position effects from X-autosome translocations in the mouse; changes induced by age in oocyte numbers in rats; the cytological detection of translocations in the mouse; tissue culture techniques for cytogenetic studies of the mouse; and results of studies on the reproductive capacity of female mice. (C.H.)

3863 (ORNL-2997(p.87-96)) RADIATION PROTECTION—LIVING CELLS. A. Hollaender, G. E. Stapleton, et al. Oak Ridge National Lab., Tenn.

Progress is reported in studies of factors affecting the radiosensitivity of Escherichia coli and yeast. Topics discussed include culture conditions as determinants of x-ray sensitivity of Escherichia coli; the sensitivity of Escherichia coli to catalase activity, hydrogen peroxide, and ionizing radiation; the effects of products formed during ultraviolet irradiation of methyl linolenate on growth and cell division in yeast; and the protection of E. coli against the effects of x radiation with β-mercaptoethylamine. (C.H.)

3864 (ORNL-2997(p.97-113)) MAMMALIAN RADIATION RECOVERY. C. C. Congdon, R. R. Bigelow, et al. Oak Ridge National Lab., Tenn.

Progress is reported in studies of mammalian recovery from radiation injury. Topics discussed include the histologic pattern of normal organized lymphatic tissue in mice; the origin of antibody-forming cells of the spleen of long-term homologous bone marrow and fetal liver chimeras; biochemical changes and increased liver weight in bone marrow chimeras; the effect of the removal of lymphatic tissue on anti-sheep red blood cell production in mice; leucine and cytidine incorporation into abnormally enlarging mouse intestinal crypt cells after x irradiation; the erythrocyte life span in strain-2 guinea pigs; the formation of donor type lymphoid cells in homologous and heterologous bone marrow chimeras; chromosome aberrations induced in vivo by x irradiation of hamsters; and visible chromosome aberrations induced by irradiation of the male germ cells of the mouse. (C.H.)

3865 (ORNL-2997(p.114-24)) RADIATION IMMUNOLOGY. T. Makinodan, N. Gengozian, et al. Oak Ridge National Lab., Tenn.

Progress is reported in studies on the nature of antigens and antibodies. Topics discussed include the radiosensitive nature of primary and secondary antibody-forming cells; the phagocytosis of heterologous red blood cell antigens by mouse peritoneal exudate cells; development of a model for studying hematopoietic transplantation antigens; the course of fatal anaphylaxis in mice as influenced by dose and route of sensitization and time of challenge; and studies on passive anaphylaxis in the chicken. (C.H.)

3866 (ORNL-2997(p.125-39)) PATHOLOGY AND PHYSIOLOGY. G. E. Cosgrove, M. Asano, et al. Oak Ridge National Lab., Tenn.

Progress is reported in a number of studies on the pathological and physiological effects of radiation in mammals. Topics discussed include the modification of homologous disease following transplantation of parental bone marrow and recipient liver in irradiated hybrid mice; the acute effects in mice of various alkylating agents; the influence of dose rate on the effectiveness of γ rays for delayed somatic effects in mice; the effect of induced thrombocytopenia on peripheral platelet count in rats; the effects of intravenous administration of nitrogen mustard on mouse brain; protein metabolism in the rat-mouse chimera; erythropoiesis by normal nucleated peripheral blood cells injected into x-irradiated recipient mice; and electron microscopic studies of plasma-cell tumors of the mouse. (C.H.)

3867 (ORNL-2997(p.140-54)) CELL PHYSIOLOGY. N. G. Anderson, R. R. Becker, et al. Oak Ridge National Lab., Tenn.

Progress is reported on studies on the isolation and characterization of soluble tissue proteins; the separation of fatty acids from lipids of rat liver microsomes; studies on serum inhibitors of lipid peroxide formation; the development of a rapid method for the determination of adenosinetriphosphatase and apyrase; the preparation of rat serum macroglobulins; the development of a procedure for automatic sampling from electrophoresis cells; the effects of subzero temperatures on yeast cells; some effects of cytoplasmic proteins on nuclei and their implications for embryonic differentiation; the isolation and characterization of adult fowl serum proteins; and a study of basic proteins of frog oocytes. (C.H.)

3868 (ORNL-2997(p.164-6)) CHEMICAL PROTECTION AND ENZYME CATALYSIS. D. G. Doherty, F. C. Grimm, et al. Oak Ridge National Lab., Tenn.

Relatively small changes in the molecules of the parent compounds were found to markedly effect the radiation protective activity of s,2-aminoethylisothiourea and 3-aminopropylisothiourea. The introduction of hydrophilic groups into the molecule on the amidine nitrogen atoms was found to reduce the toxicity, but unfortunately also lowered the protective activity. The introduction of hydrophobic groups practically abolished the radiation protective effects. Further improvements in a protein fractionation procedure yielded a 90% pure beef heart malic dehydrogenase. Diffusion studies are in process to allow an estimation of the molecular weight of the purified enzyme. (C.H.)

3869 (UR-580) THE BIOLOGICAL EFFECTS OF UPPER BODY X-IRRADIATION OF BEAGLES. Carl L. Hansen, Jr., Sol M. Michaelson, and Joe W. Howland. Rochester, N. Y. Univ. Atomic Energy Project. Sept. 16, 1960. 111p. Contract W-7401-eng-49. OTS.

Results are reported from a study designed to delineate the biological effects of upper body (head and thorax) irradiation of beagles exposed to 1000 kvp x rays. Ninety-five pure-bred adult beagles of both sexes were used. Groups

of ten dogs were exposed to 800, 1000, 1500, 1750, and 2000 r midline tissue dose. In addition, a control group of ten dogs was sham irradiated under similar conditions to that of the 1500 r group. The remainder of the animals were used for whole-body irradiation. The clinical course, including physical and neurological changes from the pre-irradiation pattern, is described; the hematological and pathological findings also are described. The median lethal dose (LD-50/30) for upper-body irradiation was determined to be 1775 r as compared to 250 r for whole-body irradiation. Lethality is considered to be associated with damage to several organ systems, making the animal vulnerable to bacterial invasion. (auth)

3870 (USNRDL-TR-469) THE TOLERANCE OF RATS TO A COLD ENVIRONMENT DURING MULTIPLE EXPOSURE TO A LOW DOSE OF X RAYS. B. D. Newsom and D. J. Kimeldorf (Naval Radiological Defense Lab., San Francisco). Oct. 11, 1960. 18p.

A lethal dose of x irradiation can be made sublethal by the fractionation of a dose into a series of smaller doses separated by adequate time intervals. The results reported here demonstrate how an environmental stress, such as cold, may affect this mitigating action of dose fractionation. Rats were maintained at 6°C while receiving a total dose of 600 r in one or eight exposures with various intervals between exposures. A greater interval was required between radiation exposures at 6°C than at 23°C to reduce the lethal response following irradiation. From the results of the food consumption measurements, it appears that cold exposure emphasizes the consequence of the reduced food intake which follows daily doses of 75 r in the rat. The irradiated rat was able to increase the amount of food consumed during cold exposure; however, the increase was not sufficient for adaptation. The lowered consumption which followed eight daily 75-r exposures was sufficient to cause death in pair-fed rats maintained at 6°C but not at 23°C. (auth)

3871 (A/AC.82/G/R.206) RADIATION AND HUMAN HEREDITY. (Translation). Akademiya Nauk S.S.S.R. [1957?.]. 22p.

The genetic consequences of an uncontrolled increase in the radiation level of the human environment are discussed. Data are reviewed from a number of studies on the genetic effects of radiation in plants and animals. 62 references. (C.H.)

3872 (A/AC.82/G/R.207) THE EFFECT OF RADIATION ON THE HISTOLOGICAL STRUCTURE OF MONKEY TESTES. (Translation). Akademiya Nauk S.S.S.R. [1957?]. 25p.

An analysis was made of the morphology of the testes in normal monkeys of various ages. The effects of irradiation at various developmental stages of the testes were studied. over a 2-year period. Results indicate that restoration of normal processes takes place very slowly in animals exposed before reaching sexual maturity and that some of the damage is irreversible. (C.H.)

3873 (JPRS-2927) BIOCHEMICAL SHIFTS IN SHOCK PRODUCED BY THE COMBINED EFFECT OF BURN TRAUMA AND TOTAL-BODY IRRADIATION. D. A. Golubentsev and N. A. Shevyreva. Translated from Patol. Fiziol. i Eksptl'. Terap. 4, No. 1, 14-19(1960). 13p. OTS.

The shock state that develops in dogs and rats during the first few hours after the combined effect of burn trauma and total-body external irradiation is characterized by the rapid depletion of the glycogen reserves of the body, the accumulation of lactic acid and inorganic phosphate in the blood, and a brief hyperglycemic reaction, which is then replaced by a persistent reduction in the blood sugar to hypoglycemic levels. Total-body external irradiation even with a dose near the absolute minimum lethal dose level, does not cause any such changes in carbohydrate metabolism during the first few hours or days. Changes in the carbohydrate metabolism which are observed during the first few hours following the combined effect are determined chiefly by the burn trauma. Total-body irradiation that is superimposed on the burn trauma leads to a more severe course of the pathological process, the earlier death of the animals, and a disturbance of the compensatory metabolic reactions. (auth)

3874 (JPRS-5614) HISTOPATHOLOGICAL CHANGES IN THE CENTRAL NERVOUS SYSTEM DUE TO THE TOTAL ACTION OF GAMMA-RAYS IN LARGE DOSES ON THE ANIMAL ORGANISM. (Gistopatologicheskiye Izmeneniya v Tsentral'noy Nervnoy Sisteme pri Obshchem Vozdeystvii na Organism Zhivotnykh Gamma-Luchey v Bol'shikh Dozakh). A. F. Bibikova. Translated from Zhur. Nevropatol. i Psikhiatrii im. S. S. Korsakova 60, 529-34(1960). 10p. OTS.

Histological studies were made on the central nervous system of dogs exposed to doses varying from 5000 to 20,000 r γ radiation. Pathological processes are described. (C.H.)

3875 (JPRS-5729) CHANGES IN GLUCOSE ABSORPTION IN COMBINED RADIATION INJURIES (GENERAL IRRADIATION COMBINED WITH BURNS). (Izmeneniya Vsasyvaniya Glyukozy pri Kombinirovannykh Radiatsionnykh Porazheniyakh (Obshcheye Oblucheniye y Sochetanii s Ozhogami)). D. A. Golubentsev and N. A. Shevyreva. Translated from Eksptl. Khirurg. 5, No. 3, 57-8(1960). 3p. OTS.

The absorption of glucose from the intestines of rats in injuries from total irradiation and burn trauma was studied. A 700 r dose was followed by boiling water burns over 14 to 19% of the body surface of rats. The Kori coefficient of glucose absorption was measured for 6 days after injury. No substantial change in glucose absorption was found for burns, but radiation and radiation-burn traumas led to a considerable reduction. (T.R.H.)

3876 PATHOLOGIC EFFECTS OF THERMAL NEUTRONS AND THE B^{10}(n, ALPHA)Li^7 REACTION ON SKIN. S. W. Lippincott, J. S. Robertson, V. P. Bond, E. P. Cronkite, O. D. Easterday, and L. E. Farr (Brookhaven National Lab., Upton, N. Y.). A.M.A. Arch. Pathol. 68, 639-50(1959) Dec. (BNL-4226).

The effects in tissue of uncharged and charged particles of both low and high energy. The pig was selected because its skin, utilized as the tissue of reference, is histologically similar to that of man. The times of killing the animals following irradiation exposure were 15, 24, 25, and 112 days. The B^{10} (n,α) Li^7 reaction was followed by pathologic alterations, characterized by areas of atrophy and of epidermal and dermal necrosis. In one pig, a minute squamous-cell carcinoma was observed in the ear. The animal, killed on the 112th day, had a deep ulcer with a heavy granulation-tissue base, showing vascular changes. such as excessive capillary formation and bizarre endothelial-cell proliferation. (auth)

3877 THE EFFECT OF WHOLE-BODY RADIATION AND INFECTION ON ARTERIAL REPLACEMENT. Richard W. Hardy, Luis A. Perales, Geoffrey A. Boughton, Erving F. Geever, Roger T. Sherman, and William H. Moncrief, Jr. (Walter Reed Army Medical Center, Washington, D. C.). Ann. Surg. 151, 359-66(1960) Mar.

The use of autogenous vein grafts and plastic arterial

prostheses is not contraindicated in wounding with concomitant sublethal radiation under the conditions of this study. Their use in contaminated wounds may be acceptable if thorough debridement and active treatment of infection is done. The long-term fate of vein grafts is such that they are not the arterial replacement of choice but are to be used when suitable plastic prosthetic material is not available. (auth)

3878 THE EFFECT OF HOMOLOGOUS MARROW TRANSPLANTATION ON THE SURVIVAL OF MONKEYS FOLLOWING SUBLETHAL WHOLE-BODY RADIATION. Frances E. Newsome and R. R. Overman (Univ. of Tennessee, Memphis). Blood 16, 1762-9(1960) Dec.

Homologous bone marrow given to the rhesus monkey 30 hr after an LD 10 radiation dose of 550 r increased the mortality rate expected from the radiation alone. The symptoms produced resembled those obtained at higher doses of radiation. The effects of marrow given 48 hr after radiation differed little from those produced by the radiation alone. It is suggested that the 30-hr injection elicited a more violent reaction or that the reaction occurred during a more decisive time in the process of recovery. (auth)

3879 OBSERVATIONS ON THE CHANGES IN THE KINETICS OF RED CELL PROLIFERATION FOLLOWING IRRADIATION AND HYPERTRANSFUSION. Frederick Stohlman, Jr. (Public Health Service, Bethesda, Md.). Blood 16, 1777-87(1960) Dec.

Data are presented on the changing pattern of the Fe^{59} uptake and emergence curve following irradiation and hypertransfusion. The data obtained appear to be inconsistent with the notion that population pressure influences the release of red cells from the marrow. The implications of these data on the understanding of the kinetics of red cell production are discussed. (auth)

3880 IMMUNE HAEMOLYSIS IN RABBIT RADIATION-CHIMAERAS. K. A. Porter (St. Mary's Hospital, London). Brit. J. Exptl. Pathol. 41, 72-80(1960) Feb.

In rabbit radiation-chimeras which develop secondary disease there is a rapid destruction of Cr^5-labeled host erythrocytes. This hemolysis is only seen in association with secondary disease and does not occur in chimeras produced by treatment with fetal tissue. The destruction of red cells is selective, labeled donor cells remaining unharmed. The accompanying positive direct Coomb's test suggests that the hemolysis is an immune one. These facts strongly support the hypothesis that this hemolysis, in common with the whole syndrome known as secondary disease, is due to an immune reaction by the graft against the host. Jaundice will appear in the ailing chimera only if there is also cirrhosis of the liver due to coccidiosis. (auth)

3881 CELLULAR AND INTERCELLULAR CHANGES AFTER MECHANICAL, CHEMICAL OR RADIATION INJURY OF CONNECTIVE TISSUE. H. Z. Movat, R. H. More, and D. Wolochow (Queen's Univ., Kingston, Can.). Brit. J. Exptl. Pathol. 41, 97-104(1960) Apr.

Mechanical injury (incision) of the rabbit's skin is followed by hemorrhage into the incision. Fibrin is precipitated along the cut edges and in the depth of the incision. The conglomeration and inspissation of plasma, but particularly fibrin, results in the formation of typical fibrinoid. A fibrinoid degeneration of collagen does not occur under these circumstances. The exudate furnishes the matrix for the formation of a young, acid mucopolysaccharide-rich connective tissue, which later is converted into a collagenous scar. After chemical injury of the rabbit's skin by trypsin, degeneration and necrosis of connective tissue occur accompanied by an acute (polymorphonuclear) inflammatory reaction. A concomitant fibrinous exudation is found in the wall of a large number of vessels and in the surrounding connective tissue. The unorganized remnants of fibrin found in this tissue have the morphological and tinctorial characteristics of fibrinoid. Fibrinoid in trypsin injury does not derive from ground substance or collagen, but from an inspissation of exuded plasma, predominantly fibrin. The increased acid mucopolysaccharides in areas of damage and fibrin deposition represent early regeneration and repair of connective tissue. The changes after physical (radiation) injury are in part also a fibrinous exudate. Fibrinoid in this instance also develops from exudation and inspissation of the exuded plasma proteins. Vascular injury seems to be the causative factor in this exudation. Damage to collagen and ground substance is manifested as a swelling and disintegration, but no "fibrinoid degeneration" of connective tissue takes place. Fibrinoid can develop under various unrelated conditions and is therefore nonspecific. A plasma cellular reaction does not occur in the lesion which follows nonspecific, i.e., mechanical, chemical, or physical injury of connective tissue. This absence of plasma cells gives further support to the hypothesis that plasma cells appear only in association with antigenic stimulation. (auth)

3882 TWO-PHASE ULCERATION IN GUINEA-PIG SKIN FOLLOWING LOCAL IRRADIATION WITH X-RAYS. P. G. Mellett, J. B. Walter, and L. E. Houghton (Harefield Hospital, [London], and Royal Coll. of Surgeons of England, London). Brit. J. Exptl. Pathol. 41, 160-8(1960) Apr.

Twenty-two adult albino guinea pigs were exposed to x-ray doses of approximately 6000 r over a circular field 2.6 cm in diameter on both flanks. Two phases of ulceration were observed. Pathological findings are described. (C.H.)

3883 EFFECTS OF PROTRACTED IRRADIATION ON THE BLOOD-FORMING ORGANS OF THE RAT. PART II. DIVIDED DOSES. A. H. Pontifex and L. F. Lamerton (Royal Cancer Hospital, London). Brit. J. Radiol. 33, 736-47(1960) Dec.

Studies are reported of the response of the blood and bone marrow of rats to daily doses of whole-body x irradiation ranging from 200 to 15 rads per day and given at a dose rate of about 30 rads/min. The results are compared with those obtained using continuous irradiation. The response is similar in that a steady state in the peripheral blood count can be maintained for long periods of time at the lower dose rates, but under divided doses of radiation the steady state is represented by a subnormal level of peripheral blood count. Also the total radiation doses that can be accumulated before death at the various dose rates are somewhat lower with divided than with continuous irradiation. The part played by the spleen in maintenance of mononuclear count is less marked with divided than with continuous irradiation, though in both cases splenectomy increases survival at the dose rates investigated, probably a result of a reduced platelet fall. Some discussion of possible mechanisms involved in the maintenance of the steady state is given. (auth)

3884 CATALASE LEVELS AND RADIOSENSITIVITY OF LIVER CELLS. D. K. Myers (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Biochem. and Physiol. 38, No. 12, 1489-98(1960) Dec. (AECL-1119)

Following exposure of regenerating liver to 580 r x radiation at a time when the average amount of DNA per cell nucleus has reached 1.6 times the normal value, the usual

increase in number of cell nuclei was retarded while the average amount of DNA per cell nucleus continued to rise until it approached twice the normal value. Cell division was delayed for an unusually long period following irradiation at this stage of development. On the other hand, there was no corresponding increase during liver regeneration in the effects of high doses of x radiation on diphosphopyridine nucleotide concentrations in the liver. Although the liver catalase concentration decreased during liver regeneration, inhibition of catalase activity failed to increase the radiosensitivity of liver cells. (auth)

3885 STUDY OF NORMAL AND IRRADIATED BOUNDARY TISSUE OF THE SEMINIFEROUS TUBULES OF THE RAT. D. Lacy and J. Rotblat (Univ. of London). Exptl. Cell Research 21, 49-70(1960) Oct.

Results are reported from a histochemical and morphological study on the tissue surrounding the individual seminiferous tubules of the rat testis, as seen both under normal conditions and after a heavy dose of radiation (10,000 r) applied locally. (auth)

3886 BONE MARROW CELL SEPARATION STUDIES. Joan Wright Goodman (Oak Ridge National Lab., Tenn.). Exptl. Cell Research 21, 88-97(1960) Oct.

Differential gradient centrifugation of bone marrow cell suspensions in bovine serum albumin produced layers of mixed cell types. Each layer was capable isologously of promoting survival of heavily irradiated (C57BL × 101) F_1 mice; none was more effective than fresh whole-bone marrow. Survival curves at various nucleated cell doses were established for the several layers and for whole marrow. The effective cell type or types in this system were remarkably resistant to various kinds of trauma, including the prolonged procedures of centrifugation, layer cutting, resuspension involved in the gradient separation, and exposure for as long as 4 min to distilled water. Donor mice were pretreated by several methods, including production of artificial polycythemia and injection of cobalt, cortisone, and corticotropin in attempts to alter marrow populations. The marrow, when tested in lethally irradiated mice, was at least as effective as normal marrow. Qualitatively, the separated layers obtained on differential gradient centrifugation of such pretreated marrows appeared no different from normal layers. (auth)

3887 RADIATION EFFECTS OF THYMIDINE-^{3}H AND THYMIDINE-^{14}C. H. A. McQuade and M. Friedkin (Univ. of Missouri, Columbia and Tufts Univ., Boston). Exptl. Cell Research 21, 118-25(1960) Oct.

Results are reported from a comparative study of the frequencies of chromosome aberrations induced by tritium-labeled thymidine and thymidine with C^{14} in the methyl group and in the number two position of the pyrimidine ring. C^{14} in the methyl group produced twice as many abberations as C^{14} in the pyrimidine ring. (auth)

3888 PHARMACOLOGICAL AND NEUROPHYSIOLOGICAL STUDIES ON X-IRRADIATED ANIMALS. PART II. R. Koch and D. Klemm (Universität, Freiburg i. B. and Heiligenberg-Institutes, Heiligenberg-Baden, Ger.). Fortschr. Gebiete Röntgenstrahlen u. Nuklearmed. 93, 642-7(1960) Nov. (In German)

Previous experiments on mazes, using rats given 300 r, were repeated in order to determine whether the previous findings could be explained on the basis of gastro-intestinal disturbances. It could be shown that the increase in time to get through the maze was due neither to a change of the CNS nor to any gastro-intestinal disturbance. The changes previously observed following irradiation with 500 r are most probably due to the presence of moribund animals among the sample. Observations on the spontaneous activity of mice following irradiation suggest the same conclusion. In other words, the spontaneous activity of a sample diminishes only with doses which ensures the presence of some moribund animals. Protective substances, e.g., cysteamine, produce results approximating sublethal doses. Intoxication of mice with β,β'-iminodipropionitrile produces the picture of so-called artificial dancing mice and produces increased resistance to radiation. (auth)

3889 EFFECTS OF X IRRADIATION DURING EMBRYONAL DEVELOPMENT ON MAZE CONDUCT IN THE MOUSE. Kl. Haefner (Technische Universität, Berlin). Fortschr. Gebiete Röntgenstrahlen u. Nuklearmed. 93, 648-52(1960) Nov. (In German)

Mice that had been subjected to radiation doses from 235 to 350 r on the 6th, 9th, 12th, or 14th day of embryonic development were subsequently reared. The animals showed no visible anomalies and mastered a dead-end free maze according to a particular system. The time taken to traverse the maze was compared with controls of similar age. A reduction in learning ability among irradiated animals was readily demonstrable. (auth)

3890 SOME BIOCHEMICAL ASPECTS OF THE POST-IRRADIATION MODIFICATION OF ULTRAVIOLET-INDUCED MUTATION FREQUENCY IN BACTERIA. C. O. Doudney and F. L. Haas (Univ. of Texas, Houston). Genetics 45, 1481-1502(1960) Nov.

Postirradiation treatments blocking RNA or protein synthesis lower markedly the ultraviolet-induced mutation frequency (reversion of tryptophan requirement) in Escherichia coli strain WP2. Treatments of less than 20 min reduce the mutation frequency to a minimal level without significant modification of the time or rate of subsequent synthesis of RNA, DNA, and protein. Therefore the mutation frequency decline process apparently is an active process, probably enzymatically mediated, and not dependent on delay in postirradiation macromolecular synthesis. The progressive loss of susceptibility of the potential mutation to these treatments is closely correlated with the progression of ribonucleic acid snythesis in the culture. A relation exists between the amount of RNA synthesized at the time of chloramphenicol addition, the relative rate of DNA synthesis in the presence of chloramphenicol, and the induced mutation frequency. Apparently only when the RNA and protein necessary for genetic replication are synthesized prior to chloramphenicol addition will DNA be formed. When the RNA and protein involved have not been formed, the potentiality for mutation is lost through the active decline process. Decline in induced mutation frequency is promoted by 5-hydroxyuridine after a considerable lag. This decline is correlated with the doubling of RNA in the culture, suggesting that the analogue causes the decline through incorporation into the RNA. However, loss of susceptibility to the 5-hydroxyuridine-promoted reduction in mutation frequency occurs prior to measurable RNA synthesis and is correlated with the mutation stabilization process. Incubation with 5-hydroxyuridine of sufficient duration to prevent all sensitive mutations does not delay DNA synthesis. Several lines of evidence indicate that DNA synthesis is the terminal event in ultraviolet-induced mutation. However, delay of DNA synthesis does not modify ultraviolet-induced mutation frequency in the absence of the active decline process

unless drastic treatments are employed which grossly alter cellular metabolism. Loss of mutation photoreversibility is correlated with DNA synthesis in the culture. Dinitrophenol (but not chloramphenicol) blocks the loss of mutation photoreversibility. (auth)

3891 IONIZING RADIATION AND AGING. A. C. Upton (Oak Ridge National Lab., Tenn.). Gerontologia 4, 162-76(1960). (In English)

The effects of radiation on longevity of mice are surveyed briefly in terms of their possible gerontologic significance. (C.H.)

3892 IMMUNOLOGICAL STUDIES ON DICTYOCAULUS VIVIPARUS INFECTION. IMMUNITY PRODUCED BY THE ADMINISTRATION OF IRRADIATED LARVAE. W. F. H. Jarrett, F. W. Jennings, W. I. M. McIntyre, W. Mulligan, and G. M. Urquhart (Glasgow Univ.). Immunology 3, 145-51(1960) Apr.

Experiments are described on the immunity to Dictyocaulus viviparus infection produced in calves by the administration of 3rd stage D. viviparus larvae partially inactivated by x irradiation. A high degree of immunity was obtained by this method. (auth)

3893 TRANSPLANTATION IMMUNITY IN THE ISOLOGOUS MOUSE RADIATION CHIMAERA. J. B. Bridges, J. F. Loutit, and H. S. Micklem (Medical Research Council, Radiobiological Research Unit, Harwell, Berks, Eng.). Immunology 3, 195-213(1960) July.

The survival of skin homo- and heterografts on isologous CBA mouse chimeras has been investigated. Homografts usually persist for considerably longer than on normal unirradiated mice. Immunization of the host against the appropriate foreign antigens before irradiation neither reduces nor increases the duration of this persistence. When an irradiated nonimmune host is restored with bone marrow from an immunized donor, a measure of immunity is transferred. If adult spleen cells from normal or immunized donors are added to the restorative inoculum, strongly antigenic foreign skins are shed with something like normal rapidity, but weakly antigenic skins may be retained for 100 days or more, and even indefinitely. Heterografts do not enjoy a span of survival comparable with that of homografts. These findings are discussed, and it is concluded that two factors are of importance in the prolongation of graft survival: (1) a weakening of the mechanism by which antigens are recognized as foreign, and (2) an over-all central depression of the immune response. (auth)

3894 EFFECT OF COBALT 60 AND X-RAY ON INFECTIVITY OF CYSTICERCOIDS OF HYMENOLEPIS DIMINUTA. J. B. Villella, S. E. Gould, and H. J. Gomberg (Univ. of Michigan, Ann Arbor and Wayne State Univ., Detroit). J. Parasitol. 46, 165-9(1960) Apr.

Tests were conducted to determine the amount of Co^{60} gamma radiation or x radiation necessary to apply to cysticercoids of Hymenolepis diminuta, the rat tapeworm, in order to render them noninfective. Cysticercoids were obtained by feeding flour beetles (Tribolium confusum) with infective eggs from the tapeworm; the cysts recovered from the beetles were irradiated and counted numbers were fed to white rats to determine their ability to produce tapeworms. A dose of 12,000 rep Co^{60} or 12,000 r x-ray prevented most cysticercoids from developing to tapeworms, and in some cases the few tapeworms that developed were stunted or sexually sterile. Doses of 15,000 rep Co^{60} or 15,000 r x ray generally prevented cysticercoids from developing into adult tapeworms. (auth)

3895 DELAYED RADIATION EFFECTS IN SURVIVORS OF THE ATOMIC BOMBINGS. A SUMMARY OF THE FINDINGS OF THE ATOMIC BOMB CASUALTY COMMISSION, 1947-1959. J. W. Hollingsworth (Atomic Bomb Casualty Commission, Hiroshima). New Engl. J. Med. 263, 481-7(1960) Sept. 8.

A population of 60,000 Hiroshima and Nagasaki citizens within 2000 m from the bomb hypocenter survived the atomic bombings of 1945 and were in residence in the two rebuilt cities in 1950. Of this group, approximately 25,000 survived under 1500 m, where radiation dose was relatively large, and 7000 experienced major acute symptoms due to irradiation. This group has provided much of the existing knowledge concerning the delayed effects of irradiation in man, and its subsequent experience offers more potential information than any other available sources for elucidation of changes in irradiated human beings. The Atomic Bomb Casualty Commission has assembled a large mechanism for collection and utilization of clinical and vital statistical data on these survivors of the bombings. The past findings of the Atomic Bomb Casualty Commission in the fields of radiation cataract, leukemia, cancer, genetic effects, in utero changes, and growth and development are summarized. Current studies in many areas of medical interest are being pursued within the framework of a predefined irradiated and nonirradiated population. (auth)

3896 LD-50 AND MITOTIC RATE OF ANIMALS AT TIME OF EXPOSURE TO X-RADIATION. Stanfield Rogers, Julius Gordon, and John McClaren (Univ. of Tennessee, Knoxville). Proc. Soc. Exptl. Biol. Med. 105, 240-1(1960) Nov.

A correlation is demonstrated between mitotic rate of individual mice at time of exposure and lethal effect of x irradiation. The significance of this finding is discussed. (auth)

3897 BIOFLAVONOIDS AND SURVIVAL TIME OF MICE EXPOSED TO MULTIPLE SUBLETHAL DOSES OF X-IRRADIATION. Benjamin H. Ershoff and C. W. Steers, Jr. (Western Biological Labs., Culver City, Calif.). Proc. Soc. Exptl. Biol. Med. 105, 283-6(1960) Nov.

Experiments were conducted to determine the effects of flavonoids on survival time of mice exposed to multiple sublethal doses of total-body x irradiation. Hesperidin and lemon bioflavonoid complex at levels of 2% or 4% in the diet had little if any protective effect. Naringen, hesperidin methyl chalcone and rutin at levels of 2% or 4% of the diet increased survival over that on the basal unsupplemented ration. (auth)

3898 SURVIVAL OF CALVES TREATED WITH AUTOLOGOUS BONE MARROW AFTER EXPOSURE TO LETHAL DOSE OF WHOLE-BODY IRRADIATION. N. S. Mizuno, V. Perman, D. D. Joel, F. W. Bates, J. H. Sautter, and M. O. Schultze (Univ. of Minnesota, St. Paul). Proc. Soc. Exptl. Biol. Med. 105, 317-20(1960) Nov.

Intravenous injection of homologous bone marrow or of a mixture of fetal liver, spleen, and thymus after exposure to a lethal dose of whole-body γ radiation failed to protect calves against death from bone marrow damage. Nine of 15 calves treated with autologous bone marrow recovered after a severe hematologic crisis; 8 of these developed normally, showed no apparent signs of late radiation damage, and had regular estrous cycles and 7 are now pregnant. (auth)

3899 EFFECT OF INTERNALLY DEPOSITED RADIOISOTOPES UPON BLOOD VESSELS OF CORTICAL

BONES. W. S. S. Jee and J. S. Arnold (Univ. of Utah, Salt Lake City). Proc. Soc. Exptl. Biol. Med. 105, 351-6 (1960) Nov.

It has been observed that after an extensive latent period following acquisition of plutonium, radiothorium, and radium in cortical bone, plugging of the haversian canals occurs which in turn results in bone necrosis. Investigation of this phenomenon with a vascular injection technique and a bone-seeking α emitter (plutonium) which deposits on surfaces of haversian canals and allows the remainder of the osteones and adjacent interstitial lamellae to be free of activity, show that death of osteocytes is principally the result of disrupted blood supply rather than direct α-ray killing. With radiothorium, concentration of α particles about haversian canals was sufficient to result in total plugging of the vascular tree within the haversian canals resulting in complete bone necrosis and inhibition of internal reconstruction of cortical bone. With radium and plutonium only about half of the canals are plugged, which allows internal reconstruction to proceed; however, the nature of the remodeling in this environment is abnormal (formation of large cavities and abnormal osteones). It is also suggested that both devitalization of bone and occurrence of large cavities weaken the bone which in turn results in spontaneous fracturing of long bones. (auth)

3900 IMMUNOLOGICALLY COMPETENT CELLS IN ADULT MOUSE LIVER: STUDIES WITH PARENT-TO-HYBRID RADIATION CHIMERAS. G. Cudkowicz and G. E. Cosgrove (Oak Ridge National Lab., Tenn.). Proc. Soc. Exptl. Biol. Med. 105, 366-71(1960) Nov.

Implantation into irradiated hybrids of viable liver cells from adult donor mice of the parental strains caused a wasting disease followed by death in over 90% of the recipients. This foreign liver disease occurred after a sublethal dose of radiation was given to the recipients or after a lethal dose followed by infusion of isologous bone marrow. It did not occur in nonirradiated recipients but occurred in only 26% of sublethally irradiated F_1 hybrids infused with isologous bone marrow. In a strain combination in which the F_1 hybrid was homozygous at the H-2 locus, and the parents should therefore have been antigenetically relatively compatible, the foreign liver disease occurred late after treatment and was enhanced by presensitization of the donor to the reciprocal parent of the hybrid. It was shown that radiation dose and liver cell dose were interrelated factors in determining the development of the disease. Deaths are ascribed to an in vivo immunologic reaction after antibody production by the grafted parental cells against F_1 antigens. Nevertheless, there is evidence of a possible immune response by the F_1 hybrid against the parent. (auth)

3901 INFLUENCE OF TOTAL BODY X-IRRADIATION ON TUMOR INDUCTION BY PAROTID TUMOR AGENT IN ADULT MICE. L. W. Law and C. J. Dawe (National Cancer Inst., Bethesda, Md.). Proc. Soc. Exptl. Biol. Med. 105, 414-19(1960) Nov.

Pleomorphic tumors of the parotid gland have been induced by PTA (polyoma virus) in nonimmune adult $C3Hf/_{BiLw}$ mice given 300 r whole-body x radiation. The latent period was long and few other primary sites were involved in tumor induction following intravenous injection of a virulent thymotrophic virus preparation. Thymic epithelial tumors, induced in 100% of mice injected in the neonatal period, did not appear in mice injected as adults. Thymectomy therefore could not be shown to have an influence on the expression of tumors in adult-injected mice. The response of x-rayed adult $C3Hf/_{BiLw}$ mice receiving salivary gland explants exposed in vitro to PTA, was in contrast similar to the response of mice receiving virus within 24 hr post partum. Tumors arising at many primary sites in a relatively short period of time were observed. No differences were found in the pathogenesis of the tumors in the groups studied here. The typical renal cortical epithelial lesions characteristic of PTA infection in newborn mice were absent in those animals receiving virus as adults. (auth)

3902 INACTIVATION OF DRY T-1 BACTERIOPHAGE BY HELIUM IONS, CARBON IONS, AND OXYGEN IONS: COMPARISON OF EFFECT FOR TRACKS OF VARIOUS ION DENSITY. Donald J. Fluke, Tor Brustad, and Ann C. Birge (Univ. of California, Berkeley and Duke Univ., Durham, N. C.). Radiation Research 13, 788-808(1960) Dec.

Dry preparations of T-1 bacteriophage were irradiated with helium ions and with stripped carbon and oxygen ions, extending previous studies of effect of LET to values unattainable with α-particles. Over a wide range in LET the effect on phage survival is a function only of the radiation dose, but for heavy ions the efficiency does decrease. A minimum requirement of either one or two ions in a track interval only a few angstrom units long is indicated for inactivation of plaque survival. The indication is against a higher minimum number of ions required. On interpretation in terms of target area, correction for δ-rays brings the phage target within morphological bounds. (auth)

3903 THE ACTION OF IONIZING RADIATIONS ON THE RESPIRATION AND ON THE AEROBIC AND ANAEROBIC GLYCOLYSIS OF EHRLICH MOUSE ASCITES CELLS. A. Caputo and B. Giovanella (Istituto "Regina Elena" per lo Studio e la Cura dei Tumori, Rome). Radiation Research 13, 809-13(1960) Dec.

The changes of some metabolic activities of Ehrlich mouse ascites cells during irradiation were studied. It was observed that the oxygen uptake is increased with increased dose, but anaerobic glycolysis is proportionally inhibited. Aerobic glycolysis is increased at lowest doses; thereafter it gradually drops and at the higher doses it remains constant. (auth)

3904 THE QUESTION OF ELECTROLYTE LOSS IN THE INTESTINAL DEATH SYNDROME OF RADIATION DAMAGE. C. C. Lushbaugh, J. Sutton, and C. R. Richmond (Los Alamos Scientific Lab., N. Mex.). Radiation Research 13, 814-24(1960) Dec.

Food in the stomach of heavily irradiated rats was found to prevent absorption of orally administered radioactive sodium and subsequent bodily concentrations of Na^{22}. Fasting the animals before irradiation and oral administration of the radioisotope prevented this abnormality. Fasting also caused sodium and potassium conservation seen as increased sodium and potassium retentions. No difference was found in the ability of rats irradiated with as much as 8000 r to conserve their total-body sodium or potassium during fasting. Similarly, no evidence was found to support the conjecture that an increased sodium loss from the whole body either is caused directly by radiation or plays a primary role in the intestinal death syndrome of radiation damage. Loss of electrolyte-containing fluids into the intestinal tract in this syndrome appears from this study to be a terminal phenomenon secondary to denudation of the intestinal mucosa with which it coincides. (auth)

3905 STUDIES ON THE EFFECTS OF RADIATION ON LIVING CELLS IN TISSUE CULTURE. II. RADIO-

SENSITIVITY OF CELLS ISOLATED FROM VARIOUS IMAGINAL DISCS AND ORGANS OF LARVAE OF DROSOPHILA MELANOGASTER. Masakatsu Horikawa and Tsutomu Sugahara (National Inst. of Genetics, Misima, Japan). Radiation Research 13, 825-31(1960) Dec.

It was previously concluded that the decrease in the percentage of pupae emerging as adults and the delay in pupation induced by radiation in larvae of Drosophila melanogaster were caused by a functional disturbance of the cephalic complex which is the source of the metamorphic hormone. In the present experiment, from the degree of incorporation of radioactive thymine-C^{14} into single cells isolated from irradiated larvae, differences in radiosensitivity of their constituent cells were found corresponding to the previous results. The ratio of P^{32} incorporation into the whole tissue compared to DNA was highest in the cephalic complex, which may indicate an increased metabolic activity of the cytoplasm. The primary sites of the radiation attack were the large and the small cells of the ring gland, which is a part of the cephalic complex. Those are assumed to be the most active cells for the secretion of the metamorphic hormone in Drosophila larvae. (auth)

3906 EFFECTS OF DIFFERENT IONIZING RADIATIONS ON HUMAN CELLS IN TISSUE CULTURE. I. IRRADIATION TECHNIQUES AND DOSIMETRY. G. W. Barendsen and T. L. J. Beusker (Gezondheidsorganisatie, TNO, Rijswikj, Netherlands). Radiation Research 13, 832-40 (1960) Dec.

The apparatus and dosimetry are described for irradiation of mammalian cells in tissue culture by α, β, and x radiation. A description is given of a special culture dish, with a bottom 0.85 mg/cm^2 thick, which permitted irradiation of the cells with α and β particles from outside. The dose of α radiation delivered to the cells was determined by counting the number of particles passing per minute through 1 μ^2, by measurement of the total current in a large ionization chamber, and with an extrapolation chamber. The dose of β radiation was measured with the extrapolation chamber. The dose of x radiation was measured with a Baldwin substandard ionization chamber and the extrapolation chamber. (auth)

3907 EFFECTS OF DIFFERENT IONIZING RADIATIONS ON HUMAN CELLS IN TISSUE CULTURE. II. BIOLOGICAL EXPERIMENTS. G. W. Barendsen, T. L. J. Beusker, A. J. Vergroesen, and L. Budke (Gezondheidsorganisatie, TNO, Rijswijk, Netherlands and Rijksverdedigingsorganisatie, TNO, Rijswijk, Netherlands). Radiation Research 13, 841-9(1960) Dec.

Effects of α, β, and x radiation on the inhibition of clone formation of human cells have been measured. With α radiation an exponential survival curve was found, whereas with x and β radiation a more complicated curve was obtained. The sensitive area calculated from the experiments with α radiation is equal to 42 μ^2, which is shown to be approximately identical with the cross-sectional area of the nucleus. The RBE of α radiation is found to range from 2.5 at high doses to at least 6.0 at low doses. Results of experiments on the addition of α and x radiation are explained on the assumption that the passage of one α particle through the nucleus of a cell is sufficient to prevent this cell from developing into a clone. (auth)

3908 ULTRAVIOLET EFFECTS OF REFRACTORY PERIOD OF NERVE. C. S. Bachofer (Univ. of Notre Dame, Ind.). Radiation Research 13, 850-3(1960) Dec.

The median giant nerve fiber of the earthworm was subjected to ultraviolet irradiation with concomitant electrical stimulation for determination of relative refractory period. A decrease in refractory period, representing an enhancement of activity, was followed by an increase and ultimate block. The results were due to an alteration of the nerve and were not dependent on concomitant irradiation. The response was dose-dependent, low dose rates producing greater enhancement. Even greater enhancement of activity was obtained by a short exposure at low intensity, after which the nerve was not irradiated. (auth)

3909 THE IRRADIATION OF THE PLEUROPNEUMONIA-LIKE ORGANISM A5969 WITH COBALT-60 GAMMA RAYS. Harold J. Morowitz and Robert C. Cleverdon (Yale Univ., New Haven and Univ. of Connecticut, Storrs). Radiation Research 13, 854-6(1960) Dec.

Results are reported from a study on the effects of radiation on the pleuropneumonia-like organism A5969, which is a very small cell. Data are presented on radioinduced clone inactivation and the role of desoxynucleic acids in inactivation. (C.H.)

3910 SOME EFFECTS OF ULTRAVIOLET IRRADIATION ON YEAST CELLS (CANDIDA UTILIS). G. Svihla, F. Schlenk, and J. L. Dainko (Argonne National Lab., Ill.). Radiation Research 13, 879-91(1960) Dec.

Effects of ultraviolet irradiation on yeast cells (Candida utilis) have been studied by ultraviolet photomicrography and by biochemical analysis of ultraviolet-absorbing cellular constituents. The results of these techniques have been correlated. Much larger doses of ultraviolet irradiation are required to produce morphological changes and altered membrane permeability than to stop the ability to form colonies. Morphological changes consist in enlargement of the vacuole, followed by a decline in cell size, and, eventually, coagulation of cellular protein. The vacuolar membrane loses its selective permeability in the same fashion as the cell membrane; vacuolar constituents are released into the cytoplasm and thence into the surrounding medium along with cytoplasmic constituents. The effect of ultraviolet irradiation is not immediate; after a sufficient dose, some time is required for the completion of the release of cellular constituents into the surrounding medium. There appears to be no selective specificity in the types of compounds released, because at 25°C essentially all material absorbing at 260 mμ is lost by the cells if the exposure to ultraviolet irradiation has been high enough. (auth)

3911 THE EFFECT OF WHOLE-BODY X-IRRADIATION ON THE ABSORPTION OF CALCIUM-45 AND STRONTIUM-85 FROM THE INTESTINAL TRACT OF THE RAT. F. W. Lengemann (State Univ. Veterinary Coll., Ithaca, N. Y.). Radiation Research 13, 892-7(1960) Dec.

Young and mature male albino rats were subjected to whole-body x irradiation (285 kvp) in an effort to determine whether the absorption of radiostrontium and radiocalcium could be altered by such a procedure. The data showed that 200 r significantly increased the amount of Sr^{85} and Ca^{45} crossing the intestine of the young rat, but 1000 r and 400 r were needed in the mature rat to increase the passage of Sr^{85} and Ca^{45}, respectively. The irradiation did not appear to alter the uptake of the radionuclides by bone, and it was concluded that the defect was produced at the intestinal level. The increased absorption of radiostrontium and radiocalcium was evident as early as 2 hr and as long as 48 hr after irradiation. Feeding and/or fasting the animals before and after irradiation had no effect on the results. (auth)

3912 GRAFTS IN SERIES OF HOMOLOGOUS BONE MARROW IN IRRADIATED MICE. D. W. H. Barnes, C. E. Ford, and J. F. Loutit. Sang 30, 762-5(1959). (In French)

Research is briefly described which supports the contention that injected hematopoietic tissue acts as a graft in irradiated animals and causes survival and recovery. (T.R.H.)

3913 INFLUENCE OF MASSIVE DOSES OF γ-RAYS ON IMMUNOLOGICAL PROPERTIES OF BACTERIA OF INTESTINAL GROUP. M. A. Tumanyan, A. P. Duplishcheva, and T. S. Sedova. Zhur. Mikrobiol. Epidemiol. i Immunobiol. No. 4, 3-10(1958).

Dysentery and typhoid vaccines were prepared from organisms killed by γ-exposure—"radioactive vaccine" (RV) and polysaccharide-protein antigenic complexes—radioactive antigens (RA). In experiments on animals it was shown that the toxicity of RV and RA did not differ from that of the usual formalized vaccine (FV) and the antigenic complexes. The toxicity of typhoid RV, determined by a subcutaneous reaction in rabbits, was somewhat less than the toxicity of FV. RV was less reactive than the heated and FV. The anaphylactic properties of both types of vaccine were the same. The antigenic properties of RV and the usual vaccines (experiments on rabbits with determination of agglutination titer) were analogous. The immunological properties were studied by immunization of mice with both forms of vaccine by an identical schedule with subsequent infection. The immunogenic properties of dysentery RV did not differ from those of FV. Radiation of FV evoked a negligible decrease of its immunogenic properties. The immunological properties of the typhoid RV after a 4-month storage were higher than those of the heated typhoid vaccine and FV. Similar data were obtained in a study of the immunological properties of RA. The ability of RV and RA to call forth the formation of protective antibody did not diverge from that of the usual vaccines and antigens. Using RGA (radioactive gamma antigen) it was shown that the Vi-antigen was preserved in irradiated cultures. The authors believe that γ-rays can be utilized for the preparation of intestinal vaccines and antigens as well as for the sterilization of correspondingly prepared bacterial preparations. (auth)

3914 COLLECTIVE EFFECTS OF ABSORPTION OF ENERGY FROM IONIZING RADIATION. Ugo Fano (National Bureau of Standards, Washington, D. C.). p.14-21 of "Collective Effects of Radiation."

The energy spectra of primary excitations produced by fast charged particles differ in the condensed and gaseous states. In the gaseous state, the energy-loss spectrum is smooth and decreases with energy, whereas in solid films it has a sharp peak in the far ultraviolet (10 to 20 ev); the latter effect is ascribed to collective excitations involving the electrons of a large volume of matter, perhaps 100 A or more in diameter. However, it cannot be said whether or not the initial collective aspect of excitations has an influence on their physico-chemical effects. The reason why range-energy relations of high-energy particles in condensed materials can be approximated from those of the same materials in the gaseous phase is because the condensation influences only the low-energy portion of the spectra. There are two types of polarization for excited states with strong dipole-dipole interactions: longitudinal and transverse. Slow charged particles excite only the first type, whereas electromagnetic radiation excites the second type. In a material with a complex frequency-dependent dielectric constant, the probability for excitation of longitudinal waves is proportional to the imaginary part of the reciprocal of the dielectric constant. The question of the localization of a low-energy loss and of an electronic state is considered. The implications of collective effects for radiation chemistry are discussed. (D.L.C.)

3915 COMPARATIVE EFFECTS OF RADIATION. Report of a Conference held in San Juan at the University of Puerto Rico, February 15-19, 1960. Milton Burton, J. S. Kirby-Smith, and John L. Magee, eds. New York, John Wiley & Sons, Inc., 1960. 444p. $8.50.

Fourteen papers are included which were presented in San Juan, Puerto Rico, on Feb. 15 to 19, 1960, and which cover elementary processes in radiation effects and final biological effects. The topics include collective radiation effects, plant growth, photoreactivation, molecular photochemistry, nucleic acids, radiation chemistry of water, direct and indirect effects, irradiated polymers, monolayers, and energy transfer. Long discussions are given at the end of all the papers together with an editors' summary of the results of the conference; discussant, author, and subject indexes are also included. Of the 14 papers, 8 are abstracted; one was previously abstracted. (D.L.C.)

3916 CONTRASTS OF INITIAL BIOLOGICAL EFFECTS RESULTANT FROM DIFFERENT TYPES OF RADIATION. C. P. Swanson (Johns Hopkins Univ., Baltimore). p.1-13 of "Comparative Effects of Radiation."

Initial biological effects of radiation taking place before radiation damage appears fully in the cell or organism are discussed with respect to the different types of radiation (x rays, ultraviolet, and infrared). The difference of x-ray effects in wet and dry organisms is discussed, and it appears that different nutritional and environmental circumstances can either enhance or greatly depress the extent of radiation injury. The ultraviolet effects present a more uniform picture since they depend on the wave length used, but experiments on the combined effects of x and ultraviolet rays are contradictory; and it may turn out that the degree of hydration plays a large role here also. Infrared rays were found to have synergistic action when combined with x rays. It is concluded that there is an enormous gap between what is known of the initial physical effects of radiation and what is known of the final biological effects. (D.L.C.)

3917 STRUCTURAL ASPECTS OF RADIATION EFFECTS ON NUCLEIC ACIDS AND RELATED SUBSTANCES. Bernard Pullman and Alberte Pullman (Université, Paris). p.105-29 of "Comparative Effects of Radiation."

The differences between the purine and pyrimidine constituents of the nucleic acids in their radiation damage behavior are discussed and rationalized on the basis of their resonance structures. It is found that, with the exception of a small inversion between guanine and hypoxanthine, the relative values of the resonance energy per π electron correspond to the relative resistances of the compounds to radiation damage, e.g., the more radiation-resistant purines have a larger resonance energy per π electron than the pyrimidines. The following topics are also treated: the role of adenine in nature, bond strength in the purine and pyrimidine molecules, hydration products of pyrimidines, liberation of purine bases, and correspondence between radioinduced and chemically induced damage. (D.L.C.)

3918 DIRECT AND INDIRECT INITIAL EFFECTS ON BIOLOGICAL SYSTEMS. M. Ebert (Hammersmith Hospital, London). p.214-39 of "Comparative Effects of Radiation."

Experimental data on direct and indirect radiation effects in biological systems are reviewed and interpreted. Some relative rate constants for reactions of OH and H free radicals in water with organic and inorganic compounds are presented. The fate of R produced by RH + H (or OH) → R + H_2 (or H_2O) is discussed. The contradictory data on radiolysis of alkali nitrates in concentrated solutions and of $Ca(NO_3)_2 \cdot 4\ H_2O$ in solid and melt phase indicate that more radiochemical work needs to be done on concentrated solutions, which are similar to the conditions in cells. The possibility of distinguishing the direct and indirect actions by means of their efficiencies is a limited one since both the efficiencies appear to be identical for varying concentrations of DNA. Another possibility of distinguishing the actions is to measure the radiosensitivity in solution (indirect action) and in the dry state (direct action) and to compare these results with the radiosensitivity in the intact cell; but even this possibility is a dubious one, as is shown by the fact that enzyme radiosensitivity varies in different cell systems and for different enzymes in the same cell. Also, the radiosensitivity of DNase was found to depend on the pH of the solution in which the enzyme was dried. For more radiosensitive processes in cells, the effects of rapid and slow freezing are discussed, and it is stated that at least one-half of the radiation damage in cells is mediated by radical intermediates from liquid water. The oxygen effect of increasing radiosensitivity is treated in detail; it appears likely that oxygen exerts its effect in the cell nucleus, which is presumed to concentrate the available oxygen. The experiments of Howard-Flanders in which T2 bacteriophage shows the oxygen effect when irradiated as a complex in E. coli B, but not when irradiated in 0.01 M thiourea, indicate that the phage DNA, when freed from its protein coat, is accessible to a peroxy radical. Finally, the interrelation of the direct and indirect action models is discussed, and it is predicted that they will merge. (D.L.C.)

3919 RADIATION EFFECTS ON MONOLAYERS CONSIDERED FROM THE BIOLOGICAL POINT OF VIEW. Franklin Hutchinson (Yale Univ., New Haven.). p.277-99 of "Comparative Effects of Radiation."

A review of radiation effects on monolayers is presented in which the question of whether the radiosensitivity of molecules adsorbed on a surface in a cell differs from that for a dilute solution or the dried and purified state is considered and the possibilities of using monolayers of biological materials for radiobiological studies are discussed. DNase adsorbed on cellulose or ion exchange resins and pentane adsorbed on silica gel were found to be more radiosensitive than in the pure states. On the other hand, bovine serum albumin whose activity was assayed serologically was found to be 10 times less radiosensitive when spread on a monolayer than in the dry solid state; the reason for this result is ascribed to radioinduced loss of solubility in the assay solution, which, however, does not lower the activity by itself. Some experiments were made on the radiosensitivity of monolayers in contact with water, but the data are contradictory. The fact that cell treatment with lysing agents increases the apparent activity of certain enzymes is explained by effects on permeability, and the increase of catalase activity of intact yeast cells by a few 10^5 rads is probably due to radiation effects on membrane permeability. The effect of ultraviolet light on protein films spread on an air-water interface is explained as being due to breaking of intramolecular bonds. The usefulness of monolayers as a radiobiological tool is emphasized; for example, a rapid increase in radiosensitivity above 10 ev is evidence for inactivation by ionization. With monolayers the average molecular weight, forces between adjacent molecules, and area occupied by the average molecule can be studied. Many membranes of molecular thickness that comprise a lipid double layer lined with protein molecules are known to exist in cells, and radiation effects on such membranes have been studied by measuring leakage of cell components from irradiated cells. The possible processes by which a molecule can pass through a cell membrane are discussed. The primary effect of radiation is suggested to break down cell membranes, and radiobiological observations are quoted in support of this view. For example, the concentration of extractable DNA in irradiated hemophilus cells does not drop until after incubation at 37°C, and this drop is completely stopped by addition of citrate. The hypothesis of membrane rupture as an important form of radiation injury is discussed with respect to possible experiments for confirming it. Irradiation studies on molecules adsorbed at interfaces other than air-water interfaces should be interesting since they would approximate more closely conditions within cells. (D.L.C.)

3920 IMMEDIATE AND LOW LEVEL EFFECTS OF IONIZING RADIATIONS. Proceedings of the Symposium Held at Venice on June 22-26, 1959. A. A. Buzzati-Traverso, ed. London, Taylor & Francis Ltd., 1960. 390p. £2 15s. ($8.00).

A symposium on immediate and low level effects of ionizing radiations was held at Venice on June 22 to 26, 1959. Separate abstracts have been prepared for 31 papers presented. (C.H.)

3921 THE DEVELOPMENT AND PROSPECTS OF QUANTITATIVE RADIOBIOLOGY. K. G. Zimmer (Univ. of Heidelberg, Ger. and Inst. of Radiobiology, Reactor Station Karlsruhe, Heidelberg and Karlsruhe, Ger.). p.1-9 of "Immediate and Low Level Effects of Ionizing Radiations."

Microwave spectroscopy yields information on the number and concentration of free radicals as a function of dose and dose rate, of time after irradiation, and of external conditions such as temperature and water content of the specimen or type and pressure of the surrounding gas. Results of a series of experiments led to the following conclusions: (1) Ionizing radiation produces free radicals in living matter. (2) The concentration of free radicals produced by radiation increases with increasing doses. (3) The concentration of detectable free radicals depends on the surrounding gas and on the water content of the specimen. (4) The concentration of free radicals decreases after the end of irradiation comparatively slowly. It remains easily measurable for intervals of minutes to many hours, depending on the material under investigation as well as on other parameters such as water content and surrounding gas. (5) The hitherto generally accepted view of absorption of radiation by living matter leading within microseconds to stable states has, consequently, to be abandoned; (6) A comparison of microwave spectra of various mixtures of radioprotective substances and of biochemicals with those of the components shows a strong molecular interaction. The same effect could be demonstrated for unicellular organisms. These observations provide prospects for further development of quantitative radiobiology. They also lend considerable support to the theoretical considerations derived by Howard-Flanders and Moore from quite different experiments which also led to assuming the production of free radicals in living matter. The detection of long-living free radicals might well ex-

plain such observations as the so-called after-effects in irradiated biological entities. As far as the present investigations go they seem to support the direct-action hypotheses to a certain extent, but they also create new possibilities for developing the indirect-action hypotheses. (auth)

3922 PRODUCTION AND LIFETIMES OF RADIATION-INDUCED FREE RADICALS IN SOME MOLECULES OF BIOLOGICAL IMPORTANCE. John S. Kirby-Smith and Malcolm L. Randolph (Oak Ridge National Lab., Tenn.). p.11-24 of "Immediate and Low Level Effects of Ionizing Radiations."

Quantitative and qualitative studies of the energy expended per free radical or magnetic center produced, the variation of radical production as a function of LET of the applied radiation, and the lifetimes of radicals produced in a number of irradiated molecules have been made by electron spin resonance techniques. The results show quite definitely that radical formation can take place with relatively high probability, and in some cases the energy expended per radical formed approaches the 34 ev value of W. Efficiency of radical production varies inversely with LET. This has been explained in terms of the spatial distribution of the primary ions or activations produced by the different radiations together with the molecular dimensions and spacings of the compounds studied. Decay studies of the radiation-induced resonances indicate that several species of centers are probably involved rather than a single type of radical or magnetic center. These physical studies also indicate that much more work is necessary to fully characterize the nature of the induced magnetic centers. They also demonstrate the great need and the experimental feasibility for kinetic studies of shorter-lived radicals in both biochemical and biological systems. Finally the comparative studies of radical induction by ultraviolet and ionizing radiations, coupled with a consideration of the chromosome breakage by these same agents, have allowed the construction of a relatively simple working hypothesis setting the probable sites for primary radiation damage to chromosomes and accounting as well for the different cytological results (chromosome aberrations) of the radiations. Although as yet no direct and absolute correlation of radical induction with observed biological end effects can be made with complete certainty, present results and the anticipated further success in examining materials in aqueous systems give considerable hope and assurance that the ESR techniques will be of increasing value in radiobiology. (auth)

3923 RADIATION-INDUCED TISSUE BREAKDOWN AND ITS RELATION TO PROTEIN CATABOLISM. Kurt I. Altman, George Gerber, and L. H. Hempelmann (Univ. of Rochester School of Medicine and Dentistry, N. Y.). p.25-32 of "Immediate and Low Level Effects of Ionizing Radiations."

It is concluded from data presented, and from related observations, that an increased rate of tissue breakdown may be demonstrated biochemically as a result of x irradiation. Furthermore, it is thought that the measurement of metabolic-turnover times of intracellular and extracellular proteins, as well as simultaneous estimates of isotope concentrations in pertinent free amino-acid pools, provide useful quantitative information concerning tissue breakdown. Thus the measurement of the effect of ionizing radiations on the integrity of cells in various organs can be evaluated in a semiquantitative or even quantitative fashion on the basis of the metabolic behavior of tissue proteins. Collagen is considered a special case among proteins with respect to its metabolism. When applied to the metabolic behavior of the connective-tissue protein, collagen, the term "tissue breakdown" assumes a special meaning. Although, generally, tissue breakdown and increased replacement rates of proteins are proceeding in a parallel fashion, accelerated connective-tissue breakdown could be the result of the replacement of highly-labeled, metabolically-accessible, amino-acid residues of collagen by similar but unlabeled residues. This would lower the average specific activity of the labeled amino-acid residue isolated and would constitute an increased collagen breakdown without involving the disruption of the fibrous structure. (auth)

3924 STUDY OF THE ACTION OF X-RAYS ON THE ASCORBIC ACID CONTENT OF SPLEEN TISSUE. A. Chevallier and S. Manuel (Université, Strasbourg). p.33-45 of "Immediate and Low Level Effects of Ionizing Radiations."

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 3422.

3925 CHANGES PRODUCED BY IONIZING RADIATIONS AND SOME RELATED AGENTS IN DNA IN VITRO AND IN VIVO. P. Alexander, J. T. Lett, H. Moroson, and K. A. Stacey (Royal Cancer Hospital, London). p.47-69 of "Immediate and Low Level Effects of Ionizing Radiations."

The effect of radiation treatments of different types on desoxyribonucleic acid (DNA) can be to break the double chain; to render the chain more flexible (referred to as coiling), as a result of which the molecule occupies a smaller volume in solution; to cross-link different DNA molecules so that eventually an insoluble gel network is formed; and to produce branches. These different reactions can be distinguished by making several different types of measurement; but if only one property such as viscosity is determined, then confusing results will often be obtained. Hydroxyl radicals (i.e., the indirect action of radiation) produce mainly double breaks, whereas irradiation by ultraviolet light gives rise to coiling. Irradiation by β and γ rays of the nuclei of sperm from fish cross-links different DNA molecules. The protein component has no part in this reaction. Although the action is direct, it can be protected by cysteamine. When DNA is irradiated with β and γ rays in fiber form, the action is direct, and there is both cross-linking and degradation. In samples that have been disorientated by being swollen in water and then dried down, degradation predominates, whereas in the fibers as isolated the two reactions occur to approximately the same extent (i.e., branching). The radiation change produced depends not only on the previous history of the sample, but it is affected also by the presence of oxygen and of sodium chloride, which crystallizes between the fibers during isolation. Preliminary experiments indicate that α rays from polonium are much less effective in producing cross-links in the nucleoproteins than are the sparsely ionizing β and γ rays. When DNA itself is exposed to α rays, only double breaks are produced; and the reaction seems to be independent of the previous history of the sample. It is tempting to suggest that cross-linking of DNA plays an important part in initiating cellular damage since there is good evidence that nitrogen mustards and other compounds that simulate the biological effects of radiation work by this mechanism. However, the fact that α rays are less efficient than sparsely ionizing radiations in producing cross-links would appear to exclude this mechanism for cellular effects although it may apply to the inactivation of viruses. The possibility is discussed

that the primary chemical event that initiates cell lesions is not the inactivation of a biologically-active macromolecule, but the breakdown of intracellular barriers. This leads to the release of the cell's own enzymes, which attack critical points such as the nucleoproteins. (auth)

3926 SOME EFFECTS OF X-RAYS ON THE IN VIVO BIOSYNTHESIS OF NUCLEIC ACIDS CAPABLE OF EXPLAINING THE REDUCTION OF ENZYMATIC ACTIVITIES AND THE OCCURRENCE OF MUTATIONS. Paul Mandel and Pierre Chambon (Faculté de Médecine, Strasbourg). p.71-87 of "Immediate and Low Level Effects of Ionizing Radiations."

The enzymes responsible for the biosynthesis of the nucleotides are less sensitive to x rays than those producing nucleic acids from these nucleotides. The difference in sensitivity to x rays of enzymes responsible for the synthesis of nucleotides and of the enzymes that produce ribonucleic acid and desoxyribonucleic acid from the nucleoside triphosphates leads to an accumulation of those nucleotides after irradiation. The decrease in the biosynthesis of ribonucleic acid, as well as the abnormal ratio between precursors, explains the lessening of the enzymatic activities and the formation of a ribonucleic acid different from the one of the cell. The accumulation in an abnormal ratio of desoxyribonucleoside triphosphates at a moment when the effect of x rays gradually vanishes and when the biosynthesis of desoxyribonucleic acid begins anew may explain the appearance of abnormal desoxyribonucleic acid and the occurrence of mutations. The conception that a variation in metabolic activity may induce a change in the normal repartition of the precursors of desoxyribonucleic acid may account for spontaneous mutations and mutations in the virus-infected cells where an active biosynthesis of desoxyribonucleotides and of viral desoxyribonucleic acid takes place. (auth)

3927 SOME ASPECTS OF THE CATABOLISM OF NUCLEIC ACIDS AFTER EXPOSURE TO IONIZING RADIATION. G. B. Gerber, G. Gerber, K. I. Altman, and L. H. Hempelmann (Univ. of Rochester School of Medicine and Dentistry, N. Y.). p.89-92 of "Immediate and Low Level Effects of Ionizing Radiations."

Changes in the metabolism of RNA and DNA induced by radiation were studied by measuring the rate of replacement of these macromolecules and by determining the isotope concentration in suitable metabolic traps. In muscle the RNA catabolism increased without concomitant changes in DNA; in intestine an increase in the catabolism of RNA occurred simultaneously with a decrease in the incorporation of thymidine into DNA; and in spleen and thymus the catabolism of DNA and RNA increased. An explanation of these findings in terms of cellular response of the involved tissue is offered. The changes in the isotope concentration in the respective metabolic traps are compatible with the conclusions drawn from data involved with nucleic acid of tissue. (auth)

3928 EFFECTS OF TOTAL-BODY X-IRRADIATION ON RAT-SPLEEN AND LIVER DEOXYRIBONUCLEASES. R. Goutier (Université, Liège), M. Goutier-Pirotte, and P. Ciccarone. p.93-102 of "Immediate and Low Level Effects of Ionizing Radiations."

An alteration induced by x irradiation of the pH-activity curves of acid DNAase from spleen and liver homogenates was found. Thirty minutes after 850 r total-body irradiation, two optimum pH's are observed at pH 4.85 and 5.15, instead of one at pH 5.15 in spleens from non-irradiated animals. The effect of purification and sulfhydryl compounds was studied and led to the conclusion that x irradiation and various chemical aggressions set the DNAase free from a complex with a substance X to which it is normally bound. A temporary increase in liver acid and neutral DNAases was observed in rats 6 and 12 hr after partial hepatectomy. The enzyme activities were back at their normal level in 24 hr regenerating liver. Irradiation performed at the sixth and twelfth hour after hepatectomy decreased the acid and neutral DNAases activity. The scope of these results is discussed. (auth)

3929 X-RAY-INDUCED CHROMOSOME ABERRATIONS IN MAMMALIAN CELLS IN VIVO AND IN VITRO. Michael A. Bender (Oak Ridge National Lab., Tenn.). p.103-18 of "Immediate and Low Level Effects of Ionizing Radiations."

Experiments with human and monkey cells in vitro have confirmed an earlier observation on human chromosomes. The spontaneous break frequencies were about 1 break per 100 cells, and the x-ray-induced frequencies in the early first post-irradiation divisions were about 0.3 breaks per 100 cells per r. Sex or age of the donor had no influence on the aberration rate. An experiment with monkey bone marrow in vivo has established that the break frequency in a rapidly dividing tissue in vivo is not very different from the in vitro frequency. The finding of Puck (1958 a) that fibroblasts in vitro display a very high spontaneous and a high induced aberration rate was confirmed by experiments with fibroblasts from the Chinese hamster in vitro and also by experiments with Chinese hamster bone marrow in vivo. (auth)

3930 ON TWO POSSIBLE MARKERS OF CHROMOSOMAL ABERRATIONS INDUCED BY X-RAYS IN HUMAN CELLS. Jérome LeJeune (Centre National de la Recherche Scientifique, Paris). p.119-23 of "Immediate and Low Level Effects of Ionizing Radiations."

Two instances are reported of the demonstration of chromosomal abnormalities induced by x radiation which are related to congenital malformations in humans. In one case of Mongolism, the malformation is related to a probable trisomy for one of the smaller chromosomes. In a case of a child presenting mild but definite physical and mental retardation and a very complex and peculiar malformation of the vertebrae, only 45 chromosomes were found. The chromosomes of the two children are illustrated and compared with normal cells. The practical application of the findings is discussed. (C.H.)

3931 BEHAVIOUR OF HUMAN BONE-MARROW CELLS CULTURED IN VITRO IN PRESENCE OF RADIOISOTOPES. SENSITIVITY TO IRRADIATION AND BIOLOGICAL DAMAGE OF THE BONE MARROW. Aminta Fieschi and Carlo Sacchetti (Università, Genoa). p.125-38 of "Immediate and Low Level Effects of Ionizing Radiations."

An attempt is made to recognize the manner in which the vital functions of human bone-marrow cells are affected by the radioisotopes Fe^{59} and P^{32} added in the culture medium. All the biological activities of the cells are impaired even by very low doses of radioisotopes. No mitotic stimulation is observed. The granuloblasts appear as the most sensitive within the bone-marrow cultured cells. The biological changes increase with increasing doses of radioactive material in an exponential fashion. The bone-marrow culture appears to be a method that is sensitive enough to detect and to evaluate the changes of cellular functions. (auth)

3932 BONE-MARROW IMPAIRMENT AND RECOVERY FOLLOWING TOTAL BODY X-IRRADIATION. Carlo Sacchetti, Franco Diena, and Aminta Fieschi (Università, Genoa). p.139-45 of "Immediate and Low Level Effects of Ionizing Radiations."

The effects of whole-body x irradiation on the bone marrow of guinea pigs were studied by means of the tissue culture method. Single 25 r total-body irradiation causes a significant increase in all the cellular activities. Values reach normal levels after four days. Repeated 25 r exposures show progressive impairment in the cellular responsiveness. Single 50 and 100 r irradiation causes cellular impairment and 15 days are required to reach recovery. The significance of the cell stimulation is discussed. The recovery after irradiation is to be considered complete only if the cellular responsiveness to a given stimulus is restored. (auth)

3933 RESPONSE OF A CATALASE-NEGATIVE BACTERIUM TO IONIZING RADIATION. Howard I. Adler (Oak Ridge National Lab., Tenn.). p.147-54 of "Immediate and Low Level Effects of Ionizing Radiations."

It has been shown that for a catalase-negative bacterium ionizing radiation has at least three functions that may be studied independently. These include immediate inactivation of a fraction of the population, sensitization of survivors to the lethal action of hydrogen peroxide, and hydrogen peroxide production in the medium surrounding the cells. The production of the sensitized state and the presence of hydrogen peroxide result in a postirradiation inactivation of cells that survive immediate inactivation. The mechanism of radiation-induced hydrogen peroxide sensitivity and the chemical reactions by which hydrogen peroxide inactivates this bacterium are being studied in the hope that they may help explain the course of radiation damage in this and other cells. (auth)

3934 MECHANISMS OF CHEMICAL PROTECTION AGAINST IONIZING RADIATION IN LIVING ORGANISMS. D. W. van Bekkum and O. Brocades Zaalberg (National Defense Research Council T. N. O., Rijswijk (Z.H.), Netherlands). p.155-66 of "Immediate and Low Level Effects of Ionizing Radiations."

The available evidence strongly supports an anoxic mechanism of action against ionizing radiations in the case of compounds which are substrates of cellular metabolism as well as in the case of the biological amines. The in vitro protection observed with cysteine and related substances can also be fully explained by the removal of oxygen. The in vivo action of cysteine is not yet satisfactorily elucidated, but the production of anoxia seems to be the most plausible mechanism. The observations on cysteamine and its derivatives indicate a different mode of action although additional work, which should include estimations of the oxygen tension in the system, is needed to eliminate anoxia as the underlying cause of the protection. Further investigations are needed to test both the mixed disulfide hypothesis and the radical scavenger hypothesis. It has not been possible to propose a satisfactory explanation for the protective activity of cyanide, which is supposed to represent the group of protective respiratory inhibitors. (auth)

3935 EXAMPLE OF IMMEDIATE LOW-LEVEL X-RAY EFFECTS: THEIR SIGNIFICANCE FOR THE STUDY OF CHEMICAL PROTECTION. R. Brinkman and H. B. Lamberts (Univ. of Groningen, Netherlands). p.167-81 of "Immediate and Low Level Effects of Ionizing Radiations."

The advantages of having a moderate-level immediate x-radiation reaction, which may be studied quantitatively in a biological system, are discussed. The properties of a number of such systems are discussed. An apparatus is described and illustrated which was designed to measure intradermal injection pressure in the rat. Applications in radiobiological studies are discussed. A system is described which was prepared by diluting synovia. Experimental results with this synovia model are reported. Results are compared with those obtained using nonliquid tissue mucopolysaccharides, the coxcomb, mammalian muscle-fascia, and the dermal layer of the skin. The protective effects against radiation injury of a number of chemicals were tested in these systems. An attempt was also made to demonstrate immediate intracellular x-ray reactions. (C.H.)

3936 ACQUIRED RADIO-RESISTANCE, RADIO-SELECTION AND RADIO-ADAPTATION. J. Maisin, E. Van Duyse, A. Dunjic, J. Van der Merckt, A. Wambersie, and D. Werbrouck (Cancer Inst., Louvain, Belg.). p.183-94 of "Immediate and Low Level Effects of Ionizing Radiations."

Experiments on Saccharomyces cerevisiae have shown that the yeast cells exposed to repeated small doses of x rays and to continuous small doses of γ rays, are more radioresistant to a subsequent heavy dose of x rays than are normal controls. Arguments were advanced which permit the concept that a phenomenon of radioadaption is being dealt with. It is a mass phenomenon. Moreover the acquired radioresistant character is a stable one, as if a phenomenon of adaptive mutation were being dealt with. The absorption of oxygen by radioadapted yeast is more important than absorption by normal yeast. The catalase activity of radiosensitive mutants is decreased in comparison with the activity of the yeast cells from which these mutants derive. Young rats exposed in utero in definite conditions and after definite doses of penetrating rays are apparently more radioresistant than normal controls. (auth)

3937 SOME CONDITIONS FOR THE PROTECTIVE ACTION OF INERT GASES. M. Ebert (Hammersmith Hospital, London) and Alma Howard. p.195-202 of "Immediate and Low Level Effects of Ionizing Radiations."

The effect of inert gases on radiosensitivity was studied with the purpose of defining conditions that may modify it and gaining a clearer idea of its possible mechanism. The radio-protective action of the inert gases has certain characteristics. An effect is seen only in the presence of oxygen, i.e., protection is afforded only against that part of radiation damage that is dependent on oxygen. When one atmosphere of air is present, and the concentration of an inert gas is increased, radiosensitivity is decreased to the value seen in the complete absence of oxygen. The effectiveness of the gases helium, nitrogen, argon, krypton, and xenon is different by a factor of about 60 for the bean root meristem. The inert-gas effect has been observed in two materials, the meristem of the broad-bean root, where damage was measured by subsequent reduction in the growth rate of the root, and in cells of the mouse Ehrlich-ascites tumor, in which chromosome abnormality was observed. The inert-gas effect presents the same general picture in these two types of cell. (auth)

3938 THE DNA LEVEL IN THE SMALL INTESTINE AS AN INDEX OF THE ACTION OF RADIOPROTECTIVE SUBSTANCES IN MAMMALS. Rodolfo Paoletti (Università, Milan). p.203-4 of "Immediate and Low Level Effects of Ionizing Radiations."

The modifications induced by radiosensitizing and radioprotective drugs on the decrease of DNA concentration in mouse small intestine after x irradiation underline that this method is of value for measuring quantitatively conditions and drugs able to modify the effect of ionizing radiations in mammals. A new series of thio-derivatives has been tested by using this method. The most active of these compounds were shown to be very active in a large series of biological tests and in clinical trials. (auth)

3939 GROWTH-RATE AND BIOCHEMICAL CHANGES IN PHYCOMYCES AT LOW DOSE-LEVELS OF X-RAYS. Arne Forssberg and Robert Novak (Karolinska Inst., Stockholm). p.205-16 of "Immediate and Low Level Effects of Ionizing Radiations."

It is demonstrated that the reversible, fluctuating growth-rate changes that occur in the irradiated sporangiophores of Phycomyces are associated with biochemical cell reactions, which in the present case run in inverse relation to the changes in growth rate. These effects are studied at two dose-levels: 1.2 r given in 5 sec and 24 r in 2 min. The initial decrease in growth rate reaches a minimum value about 3 min after a 1.2 r dose; this decrease amounts to about 60 to 70% of the normal. At this stage, or even earlier, acid-labile organic phosphates have increased to about 30% above normal. Growth rate then increases, and acid-labile phosphorus decreases in the following 5 to 10 min, whereupon steady-state level is eventually reached some 15 to 20 min postirradiation. It has been found that a chain of biochemical events, proceeding at a rapid rate, accompanies these growth reactions as visualized from the registration of changes in lactic acid concentration. (auth)

3940 REFLEX-LIKE RESPONSES OF LOWER ANIMALS AND MAMMALIAN ORGANS TO IONIZING RADIATION. Otto Hug (International Atomic Energy Agency, Vienna). p.217-26 of "Immediate and Low Level Effects of Ionizing Radiations."

Results are reported from studies on snails which indicate that the functional status of the nervous system can be affected by irradiation with relatively small doses. Certain receptors and nerve elements may be stimulated directly by ionizing radiation. This may explain some symptoms of the very early stages of radiation sickness. Further analysis of those instantaneous reactions may help clarify the primary action of ionizing radiation on living matter. (auth)

3941 THE EFFECTS OF LOW DOSES OF HIGH-ENERGY RADIATION ON VISUAL FUNCTION. Leo E. Lipetz (Ohio State Univ., Columbus). p.227-31 of "Immediate and Low Level Effects of Ionizing Radiations."

High-energy irradiation of the visual system can produce effects observable at the organ level with doses as low as half a milliroentgen. This is because the visual system is so organized that radiation can trigger a sequence of processes that amplify the energy and effect by several orders of magnitude. (auth)

3942 BINUCLEATED LYMPHOCYTES AND LOW-LEVEL RADIATION EXPOSURE. R. Lowry Dobson (Univ. of California, Berkeley). p.247-51 of "Immediate and Low Level Effects of Ionizing Radiations."

A significant increase in the numbers of binucleated lymphocytes in the blood of normal persons exposed to measured low levels of ionizing radiation was found. Data suggesting that under certain circumstances a response may perhaps be seen after single small doses were limited, although this can in no way be regarded as certain. The binucleated lymphocyte response is a small effect and is technically not easy to observe. There is reason to believe that it is a rather nonspecific effect, that it may occur as a result of stress, and that it is a reflection of recovery occurring in damaged lymphoid tissue. Very great caution is therefore required in relating this response to radiation exposure in any given case. (auth)

3943 EARLY CHANGES IN RETICULOCYTE NUMBER IN RATS, MICE AND RABBITS IMMEDIATELY AFTER X-RAY IRRADIATION. Hajduković Srdjan and Lj. Stošić (Inst. for Nuclear Sciences, Belgrade). p.253-67 of "Immediate and Low Level Effects of Ionizing Radiations."

New-born and young rats, which were 18 to 90 days old, were submitted to 700 r of x rays and reticulocyte counts made from 5 min to 24 hr after irradiation. A reticulocyte increase was observed in all animals studied except 90-day-old rats, in which irradiation is followed by a decrease in reticulocytes. There is no comparable increase of erythrocytes in spite of a marked reticulocytic crisis. Serum from new-born and young irradiated rats is capable of inducing the reticulocytic crisis in normal recipients. Radiation of the blood in vitro does not demonstrate the reticulo-stimulating properties. After centrifugation at 12,000 rpm, the lipoid layer of serum shows all the reticulo-stimulating activity, and the protein layer shows reticulocyte-depressing activity. The reticulo-stimulating factor is probably protein in nature, non-dialyzable, and it is deprived of any erythropoietic activity. The reticulocytic crisis in the experiments is of a nonspecific nature. It was induced in normal C_{3H} black mice by direct irradiation, by serum of new-born irradiated rats, and by serum of irradiated young mice. Direct irradiation is followed also by reticulocyte increase in new-born rabbits, but not in new-born dogs after 400 r; however, the serum of new-born irradiated dogs injected into nonirradiated new-born rats is followed by reticulocyte increase. (auth)

3944 INDUCTION OF MUTATIONS IN INDIVIDUAL GENES OF ESCHERICHIA COLI BY LOW X-RADIATION. M. Demerec (Carnegie Institution of Washington, Cold Spring Harbor, N. Y.) and Joan Sams. p.283-91 of "Immediate and Low Level Effects of Ionizing Radiations."

Dose effect relations were studied in three auxotrophic mutants of Escherichia coli. The lowest x-ray doses tested were 8.5 with strain arg-3 and 17 r with met-2 and thr-1. Results are summarized. (auth)

3945 THE EFFECT OF SMALL DOSES OF IONIZING RADIATIONS ON ESCHERICHIA COLI. H. Marcovich and R. Devoret (Institut Pasteur, Paris). p.293-303 of "Immediate and Low Level Effects of Ionizing Radiations."

Five examples are discussed which demonstrate an absence of deviation from linearity in radiation injury and which demonstrate that a high multiplicity in the low range of doses could not exist. This was possible because of the small size of the irradiated organisms. The discussion points out that the threshold concept is theoretically absurd, but deviations may exist in the low range of doses. These deviations may be considered in many cases as practical thresholds when the probability of the effect occurring decreases steeply with the dose to very low values. (auth)

3946 THE INFLUENCE OF METABOLIC EVENTS IMMEDIATELY AFTER IRRADIATION ON THE DIFFERENCE IN SENSITIVITY BETWEEN E. COLI B AND E. COLI B/r. Tikvah Alper and N. E. Gillies (Hammersmith Hospital, London). p.305-10 of "Immediate and Low Level Effects of Ionizing Radiations."

A few types of cell have been found to give rise to mutants that are more resistant to radiation than the parent strain. Probably the best known of these is Escherichia coli B/r, isolated from the strain E. coli B. The difference in the radiosensitivity of these two strains was attributed to a single gene change. Some comparative observations on these strains suggest that the difference in their sensitivity depends rather on the biochemical events taking place after irradiation than on the state of the primary target or targets for the lethal effect at the time the irradiation takes place. This was demonstrated by experiments on cells that had been harvested in the logarithmic stage of growth and exposed to ultraviolet at 2537 A. Cells of both strains were plated after irradiation on both nutrient medium and on synthetic salts medium, on which growth was considerably slower. E. coli B showed much greater survival on the latter medium, whereas the reverse was true of the resistant mutant. The results for E. coli B agreed with a previous report that, in general, E. coli B shows the maximum lethal effect of radiation in conditions that are optimal for growth. The results with E. coli B/r are in qualitative agreement with those reported for survival of this strain after x irradiation. (auth)

3947 DEPENDENCE OF MUTATION RATE ON RADIATION INTENSITY. W. L. Russell, Liane Brauch Russell, and Elizabeth M. Kelly (Oak Ridge National Lab., Tenn.). p.311-20 of "Immediate and Low Level Effects of Ionizing Radiations."

New data strongly support earlier results showing a lower mutation frequency with chronic γ irradiation than with acute x rays. The possibility, rather remote to begin with, that the results could be explained in terms of radiation quality (x rays vs. γ rays) rather than radiation intensity now seems to be ruled out by additional data obtained from experiments comparing mutation rates induced by acute γ irradiation with those induced by chronic γ irradiation. These additional data were obtained with the genetic criterion (specific locus mutations) and cell stage (spermatogonia) most cogent for the comparison. The view that the difference in mutation rates is due to an effect of radiation intensity on the mutation process rather than on cell selection was originally supported primarily by the results obtained with oöcytes. The additional data obtained with spermatogonia now also provide some evidence on this point. Where a probable effect of cell selection on mutation rate was found, it worked in the direction opposite to that required to account for the above difference in mutation rates. The mutation rates at 86 r and 300 r for chronic γ irradiation of spermatogonia are not higher than a linear interpolation between the control points and points at higher doses. Thus there is no evidence of a distortion of mutation rates by cell selection. The possibility that cell selection might account for the intensity effect in oöcytes was re-examined. Even when the comparison between the results from chronic and acute irradiation is restricted to follicle stages in which oöcyte killing is infrequent, an intensity effect on mutation rate is still observed. The possibility that the difference in mutation rates obtained with chronic and acute irradiation of oöcytes could be due to differences in oöcyte stage was also re-examined. Since intensity involves a time factor, it is impossible to have the oöcyte stages exactly the same in the comparison. However, when the comparison was restricted to oöcyte stages that are closely similar, an intensity effect on mutation rate was still found. The effect of radiation intensity appears to be greater in oöcytes than in spermatogonia. Various possible explanations are suggested. With acute x irradiation, the mutation rate is higher in oöcytes than in spermatogonia. (auth)

3948 THE CHROMOSOMAL BASIS OF THE MORTALITY INDUCED BY X-RAYS IN DROSOPHILA. H. J. Muller (Indiana Univ., Bloomington). p.321-5 of "Immediate and Low Level Effects of Ionizing Radiations."

Data are reviewed from a series of studies that demonstrate the permanent damage caused to individuals of an exposed generation of Drosophila by irradiation of their somatic cells. (C.H.)

3949 THE EFFECT OF RADIATION ON THE IMMUNE RESPONSE IN MICE AND ITS MODIFICATION BY TISSUE TRANSPLANTATION. P. C. Koller and Sheila M. A. Doak (Chester Beatty Research Inst., London). p.327-42 of "Immediate and Low Level Effects of Ionizing Radiations."

Sublethal irradiation (300 r) produces a suppression of the immunological response in mice for about 15 days. The period of this suppression can be reduced by lymph-node and spleen-cell transfer. The recovery of the immune mechanism in isologous chimeras occurs after 25 days. By supplementing bone-marrow therapy with lymph-node and spleen cells, it was established that the recovery is the result of donor-cell activity. The delay in the restoration of the immune control has been related to the process of repopulation and maturation of the transplanted donor cells in the irradiated host. The early immunological response of homologous chimeras has been shown, by using skin homografts, to be that of the donor strain. The characteristics of the late response are, however, variable and can be that of host-type, donor-type, or ill-defined. This variable immunological behavior suggests that during aging the activity of the lymphoid tissues in the homologous chimeras must have been modified. (auth)

3950 COMPARISON OF THE EFFECTS OF ACUTE, CONTINUOUS, AND FRACTIONATED IRRADIATION DURING EMBRYONIC DEVELOPMENT. Liane Brauch Russell, Susan K. Badgett, and Clyde L. Saylors (Oak Ridge National Lab., Tenn.). p.343-59 of "Immediate and Low Level Effects of Ionizing Radiations."

The effects of chronic irradiation accumulated during the first two weeks of prenatal development have been compared, on the one hand, with the effects of the same dose of acute irradiation given only once during the same two weeks (at one of seven stages) and, on the other hand, with the effects of daily fractions of acute irradiation given during the same interval and accumulated to the same total dose. The dose used was close to 200 r. Characters studied were mortality before, at, and after birth; weight at birth and at 36 days; fertility; and morphology. Acute irradiation produced a multiplicity of severe effects, and the data support and considerably extend the earlier finding that the type of effect produced depends strictly on the stage irradiated. Chronic irradiation during the first two weeks postfertilization appeared to have no marked ill-effects other than a shortening of the breeding period of females. Daily acute fractions, in a rather limited series, were found to have no greater effect than continuous exposure. It is postulated that the total frequency of cell killing from chronic irradiation is smaller than from acute and/or that, with chronic irradiation, the total dose received during the short period in the development of any given character when radiation damage can be caused is too small to affect more than the threshold number of cells required to produce developmental effects. (auth)

3951 EFFECTS OF LOW-LEVEL X-RADIATION DOSE FRACTIONATION ON FERTILITY IN FEMALE

MICE. L. J. Cole, J. G. Habermeyer, and H. N. Stolan (Naval Radiological Defense Lab., San Francisco). p.361-7 of "Immediate and Low Level Effects of Ionizing Radiations."

Data are presented which indicate that x-ray dose fractionation permits recovery at the cellular level in the mouse ovary. The degree of recovery is dependent on the schedule of dose fractionation and on the unit dose. It is remarkable that at the lowest unit dose employed (5 r), delivered weekly for 25 weeks, no depression in fertility, compared with nonirradiated controls, was detected. It is also evident that the greater sensitivity of weanling mice to x irradiation, as observed in this experiment, correlates well with Mandl's finding that a larger proportion of öocytes is eliminated by a given dose of radiation when immature rats are irradiated, as compared with adult mice. Of great interest in the present context, are the recent reports of Russell, Russell, and Cupp (1959) on the relationship of mutation frequency in female mice to radiation dose rate. They have found that the specific locus mutation rate in females is significantly higher following acute than following chronic irradiation. Since conditions in the adult mouse ovary are such that complications from secondary factors are unlikely, it can be concluded that there is a dose-rate effect on the mutation process itself. The problem of factors and mechanisms involved in such cellular recovery is discussed briefly. (auth)

Radiation Sickness

3952 (JPRS-2932) EXPERIENCE IN THE APPLICATION OF MYELOCYTOTOSIC SERUM IN RADIATION SICKNESS. M. F. Sbitneva. Translated from Patol. Fiziol. i Eksptl'. Terap. 4, No. 1, 39-44(1960). 11p. OTS.

The injection of myelocytotoxic serum (MCS) into dogs in a dose of 0.01 cc/kg on the first to fourth day after a single total-body irradiation (400 to 500 r) impoverishes the hematopoietic process. The use of MCS in acute radiation sickness (dose of 400 r on the 11th, 13th, and 16th day of the experiment calculating 0.01 cc/kg) exerts a slight effect on the acceleration of the recovery of the total leukocyte count and an increase in the percentage of young forms of the myeloid series, beginning with the 20th day after irradiation. Injection of MCS three times in a dose of 0.01 cc/kg a week after concluding the fractional irradiation (in a dose of 20 r per day and a total dose of 500 r) produces a more rapid recovery in total erythrocyte count of treated dogs, the earlier normalization of the ratio of erythroblastic to myeloid elements. The use of MCS in fractional irradiation with a dose of 20 r per day after a total dose of 300 r has been received produces signs of overstimulation of myelocytopoiesis and more deep-seated disturbances of erythrocytopoiesis during the process of continuing irradiation. The injection of MCS against a background of a less severe injury to hematopoiesis (with a fractional irradiation in a dose of 10 r per day and a total of 500 r and a prolonged administration of multiple vitamins) brings about a more rapid normalization of the hematopoietic processes in experimental dogs. The intravenous injection of MCS in a dose of cc/kg produces changes in the hematopoietic system in healthy dogs which superficially resemble the changes in acute radiation sickness. (auth)

3953 (JPRS-5328) AUREOMYCIN IN THE COMPLEX THERAPY OF ACUTE RADIATION SICKNESS IN DOGS. N. V. Raeva (Rayeva), N. I. Bicheikina (Bicheykina), M. I. Fedotova, and I. N. Usacheva. Translated from Farmakol. i Toksikol. 23, No. 2, 173-4(1960). 3p. OTS.

The effectiveness of aureomycin in the therapy of acute radiation sickness in dogs was evaluated. The aureomycin was administered alone and combined with other therapeutic measures that included injections of glucose, calcium chloride, ascorbic acid, and blood transfusions. The average life span of the treated dogs was 20.8 days; the average life span of the control dogs was 11.8 days. (C.H.)

3954 (JPRS-5380) FREE HOMOPLASTIC TRANSPLANTATION OF BONE MARROW AS A THERAPEUTIC AGENT IN ACUTE RADIATION SICKNESS. V. A. Revis. Translated from Vestnik Rentgenol. i Radiol. 35, No. 2, 44-52(1960). 14p. OTS.

Free homoplastic transplants of bone marrow had a beneficial effect on the survival of rabbits with acute radiation sickness. Only three rabbits succumbed from a group of 34 that received radiation doses of 700 to 1,100 r but were given bone marrow transplants. Clinical findings are described. (C.H.)

3955 (JPRS-5591) MORPHOLOGICAL CHANGES OF SYNAPTIC FORMATIONS OF THE CENTRAL NERVOUS SYSTEM IN EXPERIMENTAL CHRONIC RADIATION SICKNESS. (O Morfologicheskikh Izmeneniyakh Sinapticheskikh Obrazovaniy Tsentral'noy Nervnoy Systemy pri Eksperimental'noy Luchevoy Bolezni). A. G. Khanin. Translated from Zhur. Nevropatol. i Psikhiatrii im. S.S. Korsakova 60, 522-8(1960). 11p. OTS.

The results of histopathological studies of interneuronal synaptic bonds in the central nervous system during the development of an experimental chronic radiation disease enabled the pathology of the synaptic neuron apparatus as a toxicodystrophy which develops by stages to be characterized. The gravity of the dystrophic phenomena depended on the resistance of the organism to ionizing radiation, the total dose, and the duration of irradiation. (auth)

3956 HEMATOLOGICAL CHANGES DURING RADIATION SICKNESS. Z. Dienstbier, M. Arient, and J. Popišil (Charles Univ., Prague). Atompraxis 6, 416-21(1960) Oct.-Nov. (In German)

The authors maintain that information on the beginning and extent of the lymphocyte drop during the first 24 hr is important in evaluating the initial quantitative radiation-induced changes in the white blood picture to judge the severity and course of radiation sickness. Neutrophilia and the resultant leucocytosis, as well as eosinophilia, do not represent specific radiation reactions, and their course shows no necessary correlation with the absorbed radiation dose. (auth)

CHEMISTRY

General and Miscellaneous

3957 (GEAP-3328) EXPERIMENTAL INVESTIGATIONS OF THE REMOVAL OF SODIUM OXIDE FROM LIQUID SODIUM. G. Billuris. General Electric Co. Atomic Power Equipment Dept., San Jose, Calif. Jan. 18, 1960. 57p. For Atomics International. Div. of North American Aviation, Inc. Contract N8-S-452. OTS.

Information was obtained on the growth and characteristics of sodium oxide deposits in liquid sodium which could lead to system plugging, and the removal of sodium oxide from molten sodium by the cold trap method was studied. The data confirmed that the deposits are formed more

rapidly with an increased amount of oxygen in the sodium, cooling of the deposit area, and fluid agitation. In general, the deposits at 300°F appeared to be silver in color with patches of liquid adhering to irregular crystalline-like structures. At room temperature the deposits were relatively hard and brittle and broken pieces of the structure appeared porous. During operation of the purification loop the apparent rate of solution of sodium oxide in sodium appeared to be much slower than the rate of removal in the cold trap. The data from the cold trap deposit indicated that up to 20 vol. % sodium monoxide could be collected in the trap before significant flow restriction was apparent. The most effective packing material tested was knitted wire mesh. With any of the packings tested, and operating with a residence time of about 8 minutes or longer, the effluent sodium from the cold trap did not appear to be supersaturated with oxygen. (auth)

3958 (NAA-SR-5129) CRITICAL CONSTANTS OF DIPHENYL AND THE TERPHENYLS. H. Mandel and N. Ewbank (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1960. 33p. Contract AT-11-1-GEN-8. OTS.

The critical temperature, density, and volume of diphenyl, ortho-, meta-, and para-terphenyl, and a terphenyl mixture similar to Santowax R were ascertained by determination of the liquid and saturated vapor densities as a function of temperature. The critical temperatures were also determined by applying a rule known as the law of the rectilinear diameter. The critical pressure was determined by extrapolating the experimental vapor pressure data to the critical temperature of each compound tested. (auth)

3959 (NAA-SR-5547) THE SYNTHESIS OF BIPHENYL-2,2′,6,6′-d_4, BIPHENYL-2,2′,3,3′,5,5′,6,6′-d_8, AND BIPHENYL-d_{10}. R. I. Akawie (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1, 1960. 12p. Contract AT-11-1-GEN-8. OTS.

Biphenyl-2,2′,6,6′-d_4 was prepared from biphenyl-2,2′,4,4′,6,6′-d_6 by a 2-step synthesis. Biphenyl-2,2′,3,3′,5,5′,6,6′-d_8 was prepared from biphenyl-d_{10} by a similar 2-step synthesis. A method was developed for the preparation of biphenyl-d_{10} from biphenyl. The three deuterated biphenyls prepared were 98.2, 96.0, and 96.2 mole % pure, respectively; the impurities consisted of biphenyls with a lower deuterium content. (auth)

3960 (NAA-SR-Memo-2438) FUSED SALT SYSTEMS AS A SECONDARY COOLANT FOR THE SRE. R. E. Taylor (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 21, 1958. 18p. OTS.

The possibility of utilizing fused salts to replace sodium as the secondary coolant in the SRE was investigated. Fused-salt mixtures melting below 250°C are tabulated. A particular nitrate-nitrite eutectic would look promising if the reaction between it and sodium could be shown to be nonviolent under the conditions of a leak in the primary heat exchanger. Thirty-six halide mixtures are listed, but information concerning their corrosiveness and heat transfer properties is limited. (W.L.H.)

3961 (NAA-SR-Memo-4658) THERMO-PHYSICAL PROPERTIES OF MIXTURES OF SANTOWAX R AND DIPHENYL. R. B. Paulson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 11, 1960. 30p. OTS.

Vapor pressure, specific heat, density, viscosity, and specific enthalpy were calculated for liquid mixtures of diphenyl and Santowax-R at 500 to 800°F for high-boiler contents ranging from 0 to 30%. (C.J.G.)

3962 (SCTM-234-60(51)) INTERSYSTEM CROSSING FROM HIGHER EXCITED STATES IN COMPLEX MOLECULES. R. E. Whan and G. A. Crosby. Sandia Corp., Albuquerque, N. Mex. Oct. 7, 1960. 20p. OTS.

The general problem of intersystem crossing in complex molecules is discussed. Experimental techniques for detecting the phenomenon are evaluated, and criteria are established for selecting molecules for study. (auth)

3963 (TID-6311) NEUTRON ACTIVATION ANALYSIS BY MEANS OF SHORT-LIVED ISOTOPES. James L. Brownlee, Jr. (Michigan. Univ., Ann Arbor). June 1960. 208p. Project No. 7. Contract AT(11-1)-70. OTS.

Research was performed to evaluate the application of short-lived isotopes to analysis by radioactivation and to develop rapid chemical separations of several short-lived isotopes from a variety of sample matrices. Radioactive tracer methods were used to determine the extent of chemical recovery following separation of V^{52}, Tl^{206}, and Nb^{94m}. Determinations were made of the amount of vanadium as V^{52} in a series of petroleum process stream samples that included distillation residues and condensates. Determination of thallium as Tl^{206} was performed on rock and mineral samples. Several procedures were investigated for the chemical separation of thallium. Niobium was investigated by means of its K x ray, emitted in the decay of Nb^{94m}. Several separation procedures were investigated for the postirradiation separation of niobium from a variety of samples; only limited success was realized. (W.L.H.)

3964 (TID-6958) RADIATION-INDUCED CYANOGENATION OF ORGANIC COMPOUNDS. Quarterly Technical Status Report No. 1 Covering the Period May 1, 1960 to July 31, 1960. James A. Knight, Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Aug. 10, 1960. 10p. Project No. A-446-8. Contract AT(38-1)-202. OTS.

During this quarter, emphasis has been placed upon procurement of the necessary equipment, apparatus, chemicals, the preparation and handling of cyanogen $(CN)_2$, and solubility determination of cyanogen in benzene. An acceptable analytical procedure for determining the amount of cyanogen dissolved in an organic liquid was developed. A study of suitable tubing for chromatographic columns for use with cyanogen was initiated. Irradiations of the cyanogen-benzene system are now being planned. (auth)

3965 (TID-6975) THE USE OF RADIOISOTOPES IN THE STUDY OF MODIFICATIONS OF PLATINUM CATALYSTS. Quarterly Technical Status Report No. 4 covering Period: April 1, 1960 to June 30, 1960. James A. Stanfield (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). July 10, 1960. 11p. Project No. A-446-1. Contract AT(38-1)-202. OTS.

Hydrogenations of cinnamaldehyde in glacial acetic acid were effected in the presence of radioactive Zn^{65}. Methods were devised to determine the extent of adsorption of zinc ions on the catalyst surface. The reproducibility of these methods was studied and found to be quite good. It was shown that ordinary washings of the catalyst do not remove adsorbed zinc ions. No difference was observed between the behavior of a catalyst in the presence of a radioactive zinc chloride solution and its behavior in the presence of an ordinary zinc chloride solution. The activity of platinum

oxide toward effecting the hydrogenation of cinnamaldehyde was noted to be greater when acetic acid solvent was used rather than ethanol solvent. Although extensive efforts were made to observe some correlation between the rate of reduction and the amount of zinc salt added to the reaction mixture, no correlation was established. Similarly no correlation was observed between the rate and amount of zinc adsorbed or between the rate and the percentage of zinc adsorbed. It was noted, however, that the amount of zinc adsorbed does not increase linearly with the amount of zinc added, but rather an asymptotic relationship was noted. (auth)

3966 (UCRL-9408) BIO-ORGANIC CHEMISTRY QUARTERLY REPORT, JUNE, JULY, AND AUGUST 1960. (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 22, 1960. 51p. Contract W-7405-eng-48. OTS.

Controlled experiments to confirm the effect of deuterium and tritium in causing a disjunction in Drosophila were carried out. Both deuterium and tritium have an influence, but whether the effect is synergistic or additive is not known. Studies of radiation effects on nucleotides continued with investigation of solvents for chromatography of irradiated nucleotides, analysis for sugars and phosphates, and ultraviolet absorption spectra of irradiated nucleotides. A study on inbred BALB/c mice showed that D_2O causes sterility in some inbred strains more rapidly and completely than in outbred strains. Research continued on enzyme distribution in rat brain with studies on the determination of hexokinase in rat brain and its relative activity in various areas of the brain and with a comparison of hexokinase activity to that of cholinesterase and lactic dehydrogenase. Conclusive proof was obtained that in Papaver somniferum thebaine is the first of the octahydrophenanthrene alkaloids to be formed and is converted by successive o-demethylations to codeine and finally morphine. Brief reports are given of investigations of high-carotenoid particles in spinach chloroplasts, Hill reaction activity of small chloroplast fragments, and factors affecting the permeability of Chlorella cells to metabolites of interest. Preliminary experiments with electron spin resonance measurements in photosynthetic systems are described. Electron transfer was studied in combining halogenated quinones with perylene, N,N,N',N',-tetramethyl-p-phenylenediamine, and N,N-dimethylaniline. A proportional counter was designed for detection of radioactive components in gas chromatography. (T.R.H.)

3967 (CEA-tr-R-869) ETUDE DE LA VITESSE DE L'ÉCHANGE D'HYDROGÈNE AVEC LA PARTICIPATION DES SOLVANTS ACCEPTEURS DE PROTON. (Study of the Rate of Exchange of Hydrogen with Participation of Proton Acceptor Solvents). A. I. Shatenshtein (Shatenstein) and E. A. Yakovleva (Iakovleva). Translated into French from Zhur. Priklad. Khim. 28, 1713-23(1958). 24p.

A description is given of the preparation of deuterohydrazine, ethylamine and anhydrous ethanolamine, their isotopic analysis, and the technique used in studies of the isotopic exchange of hydrogen. The rate of isotopic exchange of hydrogen was measured in fluorene, triphenylmethane, diphenylmethane, and quinaldine with solvents and liquid ammonia. A study was made of the reason for a greater hydrogen exchange rate with hydrazine and ethylenediamine than with liquid NH_3. The peculiarities of deuterium exchange with ethanolamine are explained by the fact that it can react both as a proton donor and acceptor. A measurement was made of the rate of isotopic exchange of hydrogen in triphenylmethane with ethylenediamine by catalysis with $C_2H_5O^-$ and $NH_2C_2H_4O^-$ ions as well as with ethanolamine with $NH_2C_2H_4O^-$ catalysis. It is shown that the catalytic activity of a base depends in an important way on the nature of the solvent. (T.R.H.)

3968 (CEA-tr-R-890) RECHERCHE DANS LE DOMAINE DES SCINTILLATEURS ORGANIQUES. IV. SYNTHÈSE DES PARA-SUBSTITUÉS DU DIPHÉNYL-2, 5-OXA 1, 3, 4-DIAZOL. (Research in the Field of Organic Scintillators. IV. Synthesis of Para-Substituted Diphenyl-2, 5-oxa-1,3,4-diazole). A. P. Grekov (Gerkov), L. N. Kulakova (Koulakova), and O. P. Shavaĭka (Shavaĭka). Translated into French from Zhur. Obshchei Khim. 29, 3054-8(1959). 12p.

Nine new para-substituted diphenyl-2,5-oxadiazoles were synthesized and studied by a new method. The method involves reduction of a para-nitro group to NH_2 and diazotization followed by coupling with the desired addition reagent. (T.R.H.)

3969 (JPRS-5430) THE ACID-BASE CATALYSIS OF HYDROGEN ISOTOPE EXCHANGE REACTIONS. (O Kislotno-osnovnom Katalize Reaktsii Izotopnogo Obmena Bodoroda). A. I. Shatenshteĭn (Shatenshteyn), E. (Ye.) N. Zvyagintseva, E. (Ye.) A. Yakovleva (Yakoleva), E. Ya. (Ye. A.) Izrailevich, Ya. M. Varshavskiĭ (Varshavskiy), M. G. Lozhkina, and A. V. Vedeneev (Vedeneyev). Translated from Problemy Kinetiki i Kataliza, Akad. Nauk S.S.S.R., Inst. Fiz. Khim., Soveshchanie, Moscow, 1956 9, 218-33(Publ. 1957). 23p. OTS.

A discussion of acid-base catalysis of hydrogen exchange reactions is presented. Parameters that affect the velocity of this exchange are examined. It is noted that further development of the theory and accumulation of additional experimental data are required to fully describe the acid-base processes involved. (J.R.D.)

3970 PHOTOMETRIC TITRATION OF WEAK ACIDS IN NONAQUEOUS MEDIA. DETERMINATION OF PHENOLS IN ISOPROPYL ALCOHOL. L. E. I. Hummelstedt and David N. Hume (Massachusetts Inst. of Tech., Cambridge). Anal. Chem. 32, 1792-7(1960) Dec.

Photometric titrations of 16 weak acids, mainly phenols, were performed in commercial isopropyl alcohol using tetra-n-butylammonium hydroxide in isopropyl alcohol as titrant. In favorable cases, up to four components in a mixture were resolved if a suitable change in wave-length setting was made during the titration. Nonlinear photometric titration curves for phenols provide new evidence for complex formation between phenols and phenolate ions. (auth)

3971 CHARACTERISTIC CONSTANTS OF 2,2',4'-TRIHYDROXYAZOBENZENE-5-SULFONIC ACID, A REAGENT FOR SPECTROPHOTOMETRIC ANALYSIS. Mary H. Fletcher (U. S. Geological Survey, Washington, D. C.). Anal. Chem. 32, 1822-7(1960) Dec.

Basic data pertaining to the dye, 2,2',4'-trihydroxyazobenzene-5-sulfonic acid, as a reagent for determining zirconium are presented. Four principal dye species are indicated and are used with ionization constants to calculate the approximate absorption spectrum for any dye solution in a certain acidity range. (auth)

3972 SYNTHESIS OF PARALDEHYDE STARTING FROM BARIUM CARBONATE, WITH A VIEW TO THE DATING OF CARBONATED ARCHEOLOGICAL SPECIMENS BY LIQUID SCINTILLATION. L. Pichat, J. Clement, and C. Baret. Bull. soc. chim. France 329-33(1959). (In French) (CEA-1133)

A description is given of the synthesis of paraldehyde with barium carbonate as the point of departure, with a view to its incorporation in a liquid scintillator for the C^{14} dating of carbonated archeological specimens. $BaCO_3$ heated with metallic calcium gives calcium carbide: the acetylene obtained by the action of water is converted to acetaldehyde in the presence of a "mercurized" sulfonated exchange resin; the acetaldehyde obtained is changed to the trimer paraldehyde, which is purified by gas chromatography on a preparative scale. The over-all yield of the preparation reaches 60 to 70%. (auth)

3973 USE OF FRONTAL ANALYSIS IN ION EXCHANGE CHROMATOGRAPHY FOR STUDYING REACTIONS OF THE FORMATION OF COMPLEXES IN SOLUTION. APPLICATION TO THE HYDROCHLORIC COMPLEXES OF NICKEL, COBALT AND COPPER. Bernard Trémillon (École de Physique et de Chimie, Paris). Bull. soc. chim. France 1483-7(1958). (In French) (CEA-1176)

The method of frontal analysis on an ion exchange column provides a convenient method for studying the reactions of complex formation when these complexes are not very stable. It has the advantage of being much more sensitive and precise than the method of simple equilibrium between a solution and an ion exchanger, already used by other authors. To illustrate this method, the hydrochloric complexes $NiCl^+$, $CoCl^+$, and $CuCl^+$ were studied and their dissociation constants determined (4.6 ± 0.1, 4.0 ± 0.1, and 2.5 ± 0.1, respectively; ionic strength essentially equal to 1.5). (auth)

3974 SOME DEUTERIUM KINETIC ISOTOPE EFFECTS. IV. β-DEUTERIUM EFFECTS IN WATER SOLVOLYSIS OF ETHYL, ISOPROPYL, AND tert-BUTYL COMPOUNDS. K. T. Leffek, J. A. Llewellyn, and R. E. Robertson (National Research Council, Ottawa). Can. J. Chem. 38, 2171-7(1960) Nov. (NRC-5969)

The secondary β-deuterium isotope effects were measured in the water solvolytic reaction of alkyl halides and sulfonates for primary, secondary, and tertiary species. In every case the kinetic isotope effect was greater than unity ($k_H/k_D > 1$). This isotope effect may be associated with varying degrees of hyperconjugation or altered nonbonding intramolecular forces. The experiments make it difficult to decide which effect is most important. (auth)

3975 KINETIC ISOTOPE EFFECTS IN THE REACTION OF METHYL RADICALS WITH ETHANE, ETHANE-$\underline{d}_6$ AND ETHANE-1,1,1-$\underline{d}_3$. J. R. McNesby (National Bureau of Standards, Washington, D. C.). J. Phys. Chem. 64, 1671-4(1960) Nov.

Photolyses of acetone-$\underline{d}_6$ in the presence of a mixture of C_2H_6 and C_2D_6 and in the presence of CH_3CD_3 were carried out to measure kinetic isotope effects for the reactions: $CD_3 + C_2H_6 \rightarrow CD_3H + C_2H_5$; $CD_3 + CH_3CD_3 \rightarrow CD_3H + CH_2CD_3$; $CD_3 + CH_3CD_3 \rightarrow CD_4 + CH_3CD_2$; and $CD_3 + C_2D_6 \rightarrow CD_4 + C_2D_5$. The conclusion drawn from the results is that the relative rate constants are within experimental error: $k_1/k_4 = \exp(1500/RT)$; $k_3/k_3 = 0.73 \exp(1900/RT)$; $k_1/k_2 = 1.95 \exp(100/RT)$. (auth)

Analytical Procedures

3976 (AERE-AM-67) THE DETERMINATION OF RADIOZIRCONIUM. G. J. Hunter and M. Perkins (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). Aug. 1960. 11p. BIS.

A radiometric method for the determination of radioactive zirconium is described. Zirconium is precipitated with $Ba(NO_3)_2$ and mandelic acid. The zirconium mandelate is ignited to ZrO_2 and counted. (C.J.G.)

3977 (AERE-R-3425) THE DETERMINATION OF TRITIATED WATER IN URINE BY LIQUID SCINTILLATION COUNTING. W. P. Hutchinson. United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England. Aug. 1960. 9p. BIS.

A radiometric method for determining small amounts of tritium (0.001 μc/ml) in urine is described. (C.J.G.)

3978 (CISE-80) TECNICHE, APPARECCHIATURE E DATI SPERIMENTALI PER L'ANALISI CHIMICA E RADIOCHIMICA. 3. DETERMINAZIONE COLORIMETRICA DELL'URANIO: INFLUENZE AMBIENTALI SULLE CURVE DI TARATURA. (Techniques, Apparatus, and Experimental Data for Chemical and Radiochemical Analysis. 3. Colorimetric Determination of Uranium: Effects of Medium on the Calibration Curve). F. Gazzarrini and C. Giacoletto. Centro Informazioni Studi Esperienze, Milan. July 1960. 13p.

A study was made of the effects of the presence of certain anions on the colorimetric method for the determination of uranium using NaOH and H_2O_2. Diagrams of optical transmissivity vs. concentration were prepared for various solutions containing HCl, HNO_3, H_2SO_4, and $HClO_4$. In low concentrations, these anions did not interfere in the colorimetry of uranium. Higher perchlorate concentrations are to be avoided in solutions containing chloride and nitrate. The other ions in higher concentrations do not interfere noticeably, provided that the determination is done at higher uranium concentrations. (T.R.H.)

3979 HW-65522) AN ANALYTICAL METHOD FOR SULFUR IN NUCLEAR REACTOR GRAPHITE. D. M. Robertson. General Electric Co. Hanford Atomic Products Operation, Richland, Wash. June 6, 1960. 12p. Contract AT(45-1)-1350. OTS.

A turbidimetric method for the determination of sulfur in graphite as the sulfate formed during Eschlsa fusion of the graphite is described. (C.J.G.)

3980 (NP-9482) A PROGRESS REPORT ON THE USE OF 15 MEV DEUTERONS FOR THE DETERMINATION OF CARBON, OXYGEN, AND SILICON IN SOLID MATERIALS BY RADIOACTIVATION ANALYSIS. John W. Winchester (Massachusetts Inst. of Tech., Cambridge). Oct. 26, 1960. 29p.

Experiments were carried out to test the feasibility of radioactivation analysis for carbon, oxygen, and silicon using 15-Mev deuterons from the Massachusetts Institute of Technology cyclotron. Samples were bombarded on a stationary target placed in the external beam of the cyclotron, and induced 10 min N^{13}, 112 min F^{18}, and 157 min Si^{31} were measured by counting positron annihilation γ radiation and β radiation in a scintillation spectrometer and an end-window proportional counter. As low as 0.01% carbon in SiO_2 may be detected without chemical separation by γ decay curve resolution, and above 0.1% carbon the precision of replicate samples bombarded at the same time is a few per cent. The stoichiometry of SiO_2 may be determined to a precision of a few per cent by simultaneous β and γ counting of the bombarded sample. Detection of trace oxygen in materials by cyclotron bombardment in general requires chemical separation of induced 112 min F^{18} radioactivity. (auth)

3981 (ORNL-2987) COULOMETRIC DETERMINATION OF URANIUM IN POWER-REACTOR-FUEL-DISSOLVER SOLUTIONS. B. B. Hobbs (Oak Ridge National Lab., Tenn.). Dec. 6, 1960. 18p. Contract W-7405-eng-26. OTS.

Radioactive and nonradioactive solutions, similar to those to be found in power-reactor-fuel reprocessing, were analyzed for uranium. The procedure consisted of separation of the uranium from the dissolver solutions diverse ions by means of tri(iso-octyl)amine, acid stripping of the uranium from the organic layer, and quantitative reduction of uranium(VI) by use of a controlled-potential coulometer. The results indicated that power-reactor-fuel-dissolver solutions can be analyzed for uranium to within ±1%. (auth)

3982 (PG-Report-164) ANALYTICAL METHOD FOR THE QUANTITATIVE DETERMINATION OF THE CONSTITUENTS OF MIXTURES OF NON-CORROSIVE LIGHT GASES BY THE M.S.3. MASS SPECTROMETER. (United Kingdom Atomic Energy Authority. Production Group, Capenhurst, Ches., England). 1960. 13p. BIS.

The sample is admitted to the mass spectrometer, and the beam heights of the appropriate individual mass numbers are measured. Corrections are applied to compensate for the residual beam height and relative sensitivity of the mass spectrometer, together with the cracking pattern for each gas. The constituent molar concentrations are then calculated. The method is particularly applicable to the determination of H_2, He, O_2, N_2, Ar, CO_2, and CO; and it is readily adaptable to the analysis of other noncorrosive gas mixtures. The coefficient of variation of the method has not been determined, but is estimated to be ±5% at the 1% level, ±1% at the 10% level, and ±0.5% at the 50% level. (W.L.H.)

3983 (TID-6870) ANALYTICAL PROCEDURES FOR THE DETERMINATION OF THORIUM AND RADIUM IN URANIUM PROCESS SAMPLES. Final Report—Part I. Henry G. Petrow, Robert J. Allen, Robert Lindstrom, and Bernard Sohn. Ionics, Inc., Cambridge, Mass. Nov. 1, 1960. 18p. Contract AT(30-1)-2470. OTS.

Radiometric methods are described for the determination of thorium, radium, and their isotopes in liquid and solid uranium process samples, dust-laden filter papers, and urine. (C.J.G.)

3984 (Y-1322) SEPARATION OF URANIUM FROM URINE BY A TRI-N-OCTYLPHOSPHINE OXIDE COLUMN AND AN AUTOMATION OF THE PROCEDURE. William C. Dietrich, John D. Caylor, and Eric E. Johnson. Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn. Sept. 15, 1960. 37p. Contract W-7405-eng-26. OTS.

A method for the separation of uranium from urine has been developed. The separation consists of adsorbing uranium from partially digested urine on to a tri-n-octylphosphine oxide coated glass-bead column. Uranium is removed from the column by stripping off the reactive adsorbent with alcohol. The stripped sample is evaporated, ashed, and counted for α activity. A machine performs the adsorption, stripping, and evaporation sequences automatically. The average uranium recovery, which includes extraction efficiency, alpha attenuation and counter variability, is 73%. (auth)

3985 (AEC-tr-4313) A RAPID SPECTROGRAPHIC ANALYTICAL METHOD FOR RARE EARTH ELEMENTS. PART I. THE ANALYSIS OF COMPLEX MIXTURES OF THE RARE EARTHS. V. A. Korneev. Translated by C. Cochran Butler and E. Conrad from Zhur. Anal. Khim. 15, 170-4(1960). 11p. JCL or LC.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 17827.

3986 HIGH TEMPERATURE GAS-LIQUID CHROMATOGRAPHY. EXPLORATORY STUDIES USING AN IONIZATION DETECTOR CHROMATOGRAPH. B. J. Gudzinowicz and W. R. Smith (Monsanto Chemical Co., Everett, Mass.). Anal. Chem. 32, 1767-71(1960) Dec.

Preliminary qualitative and quantitative investigations with an ionization detector chromatograph modified for high-temperature operation were completed. Lower molecular weight hydrocarbons and complex aromatic mixtures, with some components having boiling points above 500°C, were resolved and determined. The accuracy and precision of this instrument using microgram quantities of organics are comparable to results from conventional instruments. (auth)

3987 THEORETICAL STUDY OF THE REACTION BETWEEN 2,2',4'-TRIHYDROXYAZOBENZENE-5-SULFONIC ACID AND ZIRCONIUM. Mary H. Fletcher (U. S. Geological Survey, Washington, D. C.). Anal. Chem. 32, 1827-36(1960) Dec.

Zirconium reacts with 2,2',4'-trihydroxyazobenzene-5-sulfonic acid in acid solutions to form two complexes in which the ratios of dye to zirconium are 1 to 1 and 2 to 1. Both complexes are true chelates, with zirconium acting as a bridge between the two orthohydroxy dye groups. Apparent equilibrium constants for the reactions to form each of the complexes are determined. The reactions are used as a basis for the determination of the active component in the dye and a graphical method for the determination of reagent purity is described. Four absorption spectra covering the wave length region from 350 to 750 mμ are given, which completely define the color system associated with the reactions in solutions where the hydrochloric acid concentration ranges from 0.0064 to about 7N. (auth)

3988 EXTRACTION AND FLAME PHOTOMETRIC DETERMINATION OF IRON. Oscar Menis and T. C. Rains (Oak Ridge National Lab., Tenn.). Anal. Chem. 32, 1837-41(1960) Dec.

A flame photometric procedure for the determination of iron in a variety of materials including thorium, uranium, fluoride, and phosphate is described. The iron is extracted with 4-methyl-2-pentanone from a 6M hydrochloric acid medium, after which the emissivity of the iron in the organic phase is measured at a wave length of 372 mμ. The emissivity of iron atomic lines is 20 times greater in 4-methyl-2-pentanone than in an aqueous medium, whereas that of FeO bands is increased approximately only tenfold. Iron can be quantitatively extracted with 4-methyl-2-pentanone from 4 to 8M hydrochloric acid solutions with an equilibration period of 1 min. Emulsion formation can be prevented by control of speed and duration of shaking. Of 15 elements tested for interference, only chromium(VI), molybdenum, and tin interfere when they are present at concentrations greater than 150 times that of the iron. Solutions of 1M fluoride, phosphate, and sulfate do not interfere; but 0.1M solutions of nitrate or perchlorate interfere by quenching the emissivity of iron. The calibration curves are linear for the concentrations within the range of 1 to 50 μg/ml. The coefficient of variation of the method, depending on the material, ranges from 2 to 4%. (auth)

3989 A RECORDING CONDUCTOMETRIC TITRATOR. D. W. Colvin and R. C. Propst (E. I. du Pont de Nemours & Co., Aiken, S. C.). Anal. Chem. 32, 1858-61(1960) Dec.

A conductometric titrator was developed that automatically records the conductance of a sample solution as a function of the volume of titrant added. The instrument has a linear range up to 2.6×10^4 μmho in five overlapping steps, and conductance values as high as 3×10^5 μmho can be recorded with a slight nonlinearity; however, the error is negligible and the distortion introduced into the titration curve does not limit the application of the instrument. Versatility of operation is assured since titration curves representing small changes in conductance (50 μmhos for the 350-μmho range; 2500 μmhos for the 2.6×10^4 μmho range) can be adjusted to occupy the full width of the recorder chart. The instrument has been utilized to titrate the free acid in a 25-μl aliquot of a synthetic dissolver solution with a precision of 0.6%. The solution contained 1.8M $Al(NO_3)_3$, 0.4M HNO_3, 0.001M $UO_2(NO_3)_2$, and 0.01M $Hg(NO_3)_2$. The precision for a manual titration of the same solution was 2.6%. (auth)

3990 DETERMINATION OF URANIUM AND PLUTONIUM IN URANIUM–PLUTONIUM–FISSION ELEMENT ALLOYS. R. P. Larsen and C. A. Seils, Jr. (Argonne National Lab., Ill.). Anal. Chem. 32, 1863-6(1960) Dec.

A tributyl phosphate–hydrochloric acid extraction system was used to separate uranium and plutonium from certain fission elements and from each other prior to x-ray spectrometric determination of the uranium and spectrophotometric determination of plutonium as the nitrate complex. Coprecipitation of plutonium(III) fluoride with lanthanum fluoride was also utilized to effect the plutonium separation. Coefficients of variation for both the uranium and plutonium determinations were consistently better than 1%. (auth)

3991 SEQUENTIAL ION EXCHANGE SEPARATION SCHEME FOR THE IDENTIFICATION OF METALLIC RADIOELEMENTS. W. J. Blaedel (Univ. of Wisconsin, Madison), Eugene D. Olsen, and R. F. Buchanan. Anal. Chem. 32, 1866-73(1960) Dec.

An ion-exchange separation scheme is described by which tracer amounts of over 35 metallic radioelements may be separated into six groups. In the 3.5-hr procedure, the sample is pretreated to put several elements into particular oxidation states and to complex some elements into anionic form, then adsorbed onto a column of Dowex 50W cation-exchanger, and finally eluted with a series of complexing eluents, each of controlled pH and ionic strength. The elements in each group are obtained in 15 to 30 ml of solutions containing only ammonium salts, organic acids, or hydrochloric acid. With this procedure, each of 36 elements falls predominantly into its own group, with less than 1% falling into any other group. Four elements (Pd, Au, Hg, and Ag) cannot be tolerated in the scheme. In designing the procedure, less importance was given to high yields than to clean separations; nevertheless, the yields of 31 elements are over 90%, and three more are recovered with yields above 80%. The conditions necessary for these separations were studied in detail. (auth)

3992 A MODIFIED TIN-FLUX TECHNIQUE FOR DETERMINATION OF OXYGEN IN TITANIUM. Ch. Venkateswarlu and Manley W. Mallett (Battelle Memorial Inst., Columbus, Ohio). Anal. Chem. 32, 1888-90(1960) Dec.

The standard Walter method of the determination of oxygen in titanium was reinvestigated and a modified tin-flux procedure was developed. The extraction of oxygen was carried out at 1950°C without the use of graphite chips or crucible lid, which were considered essential by early workers. Also, conditions for rapid degassing of the crucible assembly were established. (auth)

3993 SIMPLIFIED COLORIMETRIC DETERMINATION OF MERCURY. Stanley S. Yamamura (Phillips Petroleum Co., Idaho Falls, Idaho). Anal. Chem. 32, 1896-7(1960) Dec.

The dithizone colorimetric method of Friedeberg was modified for determining microgram amounts of mercury; it consists of the following steps: mercury is extracted into a xylene solution of dithizone from a chloroacetate-buffered EDTA-citric acid masking medium, stripped with HCl, neutralized with NH_3, mixed with more EDTA, and extracted into a CCl_4 solution of dithizone for color measurement at 510 mμ. Milligram amounts of Cu, Fe, Cr, Ni, and Mn do not interfere. The advantages of this modified method are as follows: xylene in the first extraction step eliminates unnecessary manipulations, citric acid increases the effective masking strength of EDTA, and the color mercury dithizonate is more stable than it is under the earlier method. This modified method was used successfully for determining trace concentrations of mercury as low as 5×10^{-6} M in dissolved MTR-type Al–U fuel elements. (D.L.C.)

General Inorganic and Physical Chemistry

3994 (GAT-T-839) X-RAY DIFFRACTION DATA FOR NINE NEW SALTS CONTAINING HEXAFLUOROURANATE(V), -MOLYBDATE(V), OR -TUNGSTATE(V) IONS. K. Ralston and F. J. Musil (Goodyear Atomic Corp., Portsmouth, Ohio). Oct. 18, 1960. 22p. Contract AT(33-2)-1. OTS.

X-ray diffraction data and physical properties such as color, stoichiometry, and density are reported for nine new compounds, six of which are reaction products of nitrogen oxides with hexafluorides and three of which are reaction products of UF_6 with various cations. The compounds are $NOUF_6$, $NOMoF_6$, $NOMoOF_4$, $NOWOF_4$, NO_2UF_6, NO_2UF_7, $Ca(UF_6)_2$, KUF_6, and $LiUF_6$. The reaction conditions giving these products are also listed. Only $NOUF_6$ and $NOMoF_6$ are indexed to a particular crystal system, the system chosen being the simple cubic system with one formula weight per cell and lattice parameters of a_0 = 5.234 A for $NOUF_6$ and 5.080 A for $NOMoF_6$. (D.L.C.)

3995 (JEN-67-DQ/I-21) DETERMINACION DE URANIO POR FLUORESCENCIA. I. PROYECTO Y EQUIPO Y COMPROBACIÓN. (Fluorescence Uranium Determination. I. Design of Equipment and Testing). R. Fernandez Cellini, F. De La Cruz Castillo, and R. Barrera Pinero (Spain. Junta de Energia Nuclear, Madrid). 1960. 20p.

Equipment for analysis by fluorescence was developed in order to make a determination of uranium at such a low concentration that previously could not be determined by the most sensitive analytical methods. This new fluorimeter was adapted to measure the fluorescence emitted by the sodium fluoride–sodium carbonate–potassium carbonate excited by ultraviolet light of 3,650 A. The intensity of the light emitted was measured with a RCA 5819 photomultiplier and associated electronic equipment. The fluorimeter gives a linear response for uranium quantities between 0 and 15 γ with a sensitivity of 0.001 γ of uranium. This procedure was used successfully as a routine method to determine uranium in very poor samples. (auth)

3996 (K-1424) PREPARATION OF STOICHIOMETRIC U_3O_8. G. S. Petit and C. A. Kienberger (Oak Ridge Gaseous Diffusion Plant, Tenn.). Nov. 30, 1960. 15p. Contract W-7405-eng-26. OTS.

Many inorganic compounds show significant deviations from stoichiometric composition; this is true of the oxides of uranium. The preparation of stoichiometric U_3O_8 depends on the starting uranium compound, sample size (bed depth), temperature, duration of ignition, and any chemical alteration of the starting compound. Stoichiometric U_3O_8 was prepared in 10-g quantities from uranyl fluoride and uranium peroxide by ignition at 850°C for 16 hr and from uranyl nitrate and uranium trioxide by ignition at 1000°C for 16 hr followed by reignition at 850°C to constant weight. Long periods of ignition to form the stoichiometric oxide are not required in the specialized gravimetric method presented for the determination of uranium. (auth)

3997 (NAA-SR-4677) KINETICS AND MECHANISM OF THE OXIDATION OF URANIUM DIOXIDE AND URANIUM DIOXIDE PLUS FISSIA SINTERED PELLETS. T. Smith. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Nov. 1, 1960. 96p. Contract AT-11-1-GEN-8. OTS.

Oxidation of uranium dioxide sintered pellets with oxygen at 3 to 800 mm Hg, 0 to 450°C and with a 0 to 5% concentration of fission product oxides (fissia) was studied in an effort to elucidate the kinetics and mechanism of the reactions involved. A mechanism is postulated for processes that control the oxidation from UO_2 to U_3O_8 in terms of the following reactions: chemisorption of oxygen on the UO_2 surface, followed by adsorption of oxygen on the chemisorbed layer [$R_i = 5.5 \times 10^{-7}$ P exp ($-12{,}800 \pm 2{,}800/RT$) moles O/cm^2-sec, where P is oxygen pressure in mm Hg]; diffusion through a thin layer (224 ± 74 Å) of U_3O_7 or U_4O_9 (depending on the temperature) with a diffusion coefficient $D = 5.5 \times 10^{-5}$ exp ($-21{,}900 \pm 1400/RT$) cm^2/sec for pure UO_2 and $D = 12.2 \times 10^{-5}$ exp ($-28{,}100 \pm 1100/RT$) cm^2/sec for pellets with fissia; formation of U_3O_8 in the grain boundaries, which causes the surface layer to spall off, and thereby pulverize the pellet. (auth)

3998 (NAA-SR-4737) A THERMOGRAVIMETRIC BALANCE FOR THE INVESTIGATION OF HIGH TEMPERATURE REACTION KINETICS AND THE RESULTS OF A BERYLLIUM OXIDATION STUDY. M. M. Nakata (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1, 1960. 27p. Contract AT-11-1-GEN-8. OTS.

A thermogravimetric balance for the investigation of high-temperature gas–solid reactions is described. The apparatus was used to investigate the beryllium–oxygen and beryllium–air reactions at 1110 to 1210°C. The initial phase of the beryllium oxidation reaction followed the parabolic rate law; the Arrhenius constant values agree with the extrapolation of the previously reported values. The reaction rate became approximately linear after a weight gain of from 0.41 to 0.56 mg cm^{-2}. The reaction rate in air was essentially the same as that in oxygen with the variation of oxygen pressure between 0.1 and 0.2 atmosphere producing no effect on the reaction rate. (auth)

3999 (NYO-2157) THIRD ANNUAL PROGRESS REPORT. L. K. Huber and A. V. Grosse. Temple Univ., Philadelphia. Research Inst. Sept. 27, 1960. 26p. Contract AT(30-1)-2082. OTS.

The properties of hydrated potassium rhenohydride, $K[ReH_4] \cdot 2H_2O$, prepared by reducing perrhenates with blue solutions of potassium in anhydrous ethylenediamine were studied further. The main result is that in dilute solutions the compound is stable not only in alkaline but in acid solutions also. By comparing these solutions with the "rhenide" solutions made in the Jones reductor, the attempt has been made to establish the nature of the rhenium compounds in both kinds of solutions. In the reduction of a perrhenate that is labeled with a pertechnetate, a technetium compound of a lower state of oxidation is formed. The presence of a technohydride, analogous to $K[ReH_4] \cdot 2H_2O$, and of the presumed composition $K[TcH_4] \cdot x\,H_2O$ was postulated on the basis of the preparation method as well as its chemical properties and behavior in coprecipitation experiments. (For preceding period see NYO-2156.) (auth)

4000 (SRIA-29) A STUDY OF SPONTANEOUS IGNITION OF METALS. Final Report for April 1, 1959–July 31, 1960. Fred E. Littman and Frank M. Church. Stanford Research Inst., Menlo Park, Calif. Aug. 15, 1960. 60p. SRI Project No. SU-2887. Contract AT(04-3)-115. OTS.

A study of the reactions occurring in the spontaneous ignition of zirconium and titanium (and their alloys), with emphasis on the former was conducted. Conditions required for spontaneous ignition, including the effects of certain impurities, surface conditions, and composition of the atmosphere around the metal, were investigated. In addition, the mechanism of ignition was studied by following the thermal history of the reactions during the first few milliseconds. (auth)

4001 (TID-6964) KINETICS OF THE REACTIONS INVOLVED IN THE FERRIC CHLORIDE ETCHING OF COPPER PHOTOENGRAVING PLATES. Quarterly Technical Status Report No. 4 covering Period: April 1, 1960 to June 30, 1960. W. H. Burrows (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). July 10, 1960. 8p. Project No. A-446-2. Contract AT(38-1)-202. OTS.

Previously used apparatus was modified to correct for irregularities in flow rates. The apparatus was calibrated, and flow rates of 700, 1400, and 2100 ml/min were chosen for comparative runs. A gas dispersion unit was included and served to introduce oxygen for studies of the effect of dissolved oxygen on etch rate. In all other runs, the gas unit will serve to introduce nitrogen, as these runs will be conducted under an inert gas blanket. Fifteen solution concentrations have been selected to replace the original eight in an effort to increase the exactness of the dissolution-rate curve. (auth)

4002 (TID-11086) THE PREPARATION OF HIGH PURITY YTTRIUM OXIDE FROM LIQUID-LIQUID CONTACTOR YTTRIUM CONCENTRATES BY MEANS OF ION EXCHANGE USING HYDROXYETHYLETHYLENEDIAMINETRIACETIC ACID AS THE ELUANT. Report No. 180. Period covered: March 26, 1958 to July 9, 1958. J. R. Morton (Michigan Chemical Corp., St. Louis, Mich.). Aug. 11, 1958. 11p. Project No. 942. OTS.

Two yttrium concentrates prepared in the liquid-liquid contactor were separated by means of ion exchange in the pilot plant. The first feed eluted with hydroxyethylethylenediaminetriacetic acid did not produce any high-purity yttrium oxide. The second feed eluted with hydroxyethylethylenediaminetriacetic acid yielded 80.6% of the yttrium as high-purity yttrium oxide. The second feed also was eluted with ethylenediaminetetraacetic acid and yielded 43.5% of the yttrium as high-purity yttrium oxide. The combination of preparation of yttrium concentrates by liquid-liquid extraction and production of high-purity

yttrium oxide by elution of the yttrium concentrates with hydroxyethylethylenediaminetriacetic acid has been highly successful in the pilot plant. (auth)

4003 (TID-11097) THE PREPARATION OF HIGH PURITY YTTRIUM OXIDE FROM LIQUID-LIQUID EXTRACTION CONCENTRATES BY MEANS OF ION EXCHANGE. Report 257. Period covered: January 21, 1959 to February 27, 1959; March 9, 1959 to April 16, 1959. L. D. McCowen (Michigan Chemical Corp., St. Louis, Mich.). June 29, 1959. 6p. Project 942. OTS.

High-purity oxide containing less than 0.1% of total impurities was successfully produced by eluting the liquid-liquid extraction feed with 0.3% hydroxyethylethylenediaminetriacetic acid (HEDTA) and 0.5% ethylenediaminetetraacetic acid (EDTA). The HEDTA yielded 74.1% yttrium oxide as high purity based on the amount of product recovered. The EDTA yielded 53.3% yttrium oxide as high purity based on the amount of product recovered. (auth)

4004 (TID-11098) PURIFICATION OF YTTRIUM OXIDE—BY ACID EXTRACTION. Report 258. Period covered: May 15, 1958 to June 11, 1958. L. D. McCowen (Michigan Chemical Corp., St. Louis, Mich.). June 30, 1959. 4p. Project 942. OTS.

The investigation of an aqueous acid scrub solution for the purification of the yttrium oxide from the primary contactor was successful while using either 0.4 normal hydrochloric acid or 0.2 normal sulfuric acid. The yttrium oxide was extracted with the aqueous scrub, and the heavy rare earths remained in the organic phase consisting of kerosene, n-decanol, and monododecylphosphoric acid. (auth)

4005 (TID-11100) PURIFICATION OF YTTRIUM BY MEANS OF LIQUID-LIQUID EXTRACTION. Report 273. Period covered: January 30, 1959 to February 15, 1959. L. D. McCowen (Michigan Chemical Corp., St. Louis, Mich.). July 31, 1959. 4p. Project 942. OTS.

The purification of 97 to 98% yttrium oxide feed was performed by means of liquid-liquid extraction on the pilot plant system. The yttrium oxide can be purified with respect to all rare-earth elements present except for cerium and lanthanum. (auth)

4006 (TID-11117) THERMOCHEMICAL STUDY OF THE SODIUM AND AMMONIUM HYDROGEN FLUORIDES IN ANHYDROUS HYDROGEN FLUORIDE. Thair L. Higgins and Edgar F. Westrum, Jr. (Michigan. Univ., Ann Arbor). [1960?]. 34p. OTS.

Enthalpies of solution of various hydrogen fluorides were determined in an electrically calibrated isothermal calorimeter that is stirred by an oscillatory motion. In addition to the enthalpy of solution data reported, the enthalpy of formation of liquid hydrogen fluoride at 298.15°K is calculated to be −71.8 kcal/mole. Enthalpies of the formation of the following fluorides are calculated to be as follows: NH_4F = −111.0 kcal/mole, NH_4HF_2 = −191.4 kcal/mole, $NH_4H_3F_4$ = −337.4 kcal/mole, $NaHF_2$ = −218.0 kcal/mole, and NaH_2F_3 = −292.5 kcal/mole. These data are used to calculate enthalpies of the decomposition of the compounds, and wherever possible these values are compared with enthalpy increments determined from the temperature dependence of pressure measurements made by other investigators. A partial confirmation of the assignment of two units of residual entropy to ammonium monohydrogen difluoride by Benjamins, Burney, and Westrum is obtained. (auth)

4007 (AEC-tr-4230) THEORY ON THE STATES OF MATTER. P. P. von Weimarn. Translated for Oak Ridge National Lab. from Z. Chem. u. Ind. Kolloide 2, 230-7 (1907-1908). 23p. JCL.

An analysis is presented of the crystallization processes in which the increase in concentration of the material under consideration is produced by a slowly increasing concentration of the solutions reacting according to the scheme A + B = AB wherein the material of interest is the product of this reaction. Supersaturation is considered, and it is noted that this occurs in all materials. In the case of easily soluble materials, large supersaturations cannot be observed because they are easily disturbed by the inhomogeneity of the systems and because the rate with which supersaturation is terminated is greater than the rate of diffusion. (J.R.D.)

4008 (AEC-tr-4287) DISTILLATION OF SULFUR FROM MINERALS. Robert Gualtieri. Translated by E. U. Kauer from Ind. mineraria 4, 270(1953). 2p. JCL.

A procedure for separation of sulfur from gangue is described. By using this procedure, fuel consumption can be reduced and at the same time the process capacity can be increased without an increase in heating capacity. The process involves recirculation of some of the combustion products. (J.R.D.)

4009 (AEC-tr-4298) STATISTICS OF ADSORBED PARTICLES IN THE ELECTRONIC THEORY OF CHEMISORPTION. Sh. M. Kogan. Translated by Lydia Venters (Argonne National Lab.) from Zhur. Fiz. Khim. 33, 156-60(1959). JCL or LC.

The absolute and relative concentrations of adsorbed particles with different types of linkage to the crystal surface were calculated within the framework of the electronic theory of chemisorption using Gibb's method for systems with variable number of particles. The method may be applied to other problems in electronic theory of chemisorption. (J.R.D.)

4010 (AEC-tr-4318) PREPARATION OF SOLUTIONS OF URANIUM SULFATE. UTILIZATION OF URANIUM SULFATE IN THE RE-EXTRACTION OF PLUTONIUM. Translation of Preparation des Solutions de Sulfate Uraneux Utilisation du Sulfate Uraneux Dans la Reextraction du Plutonium. 24p. (Includes original, 13p.). JCL.

A uranium sulfate solution is obtained by the electrolytic reduction of a uranyl sulfate solution on a mercury cathode. The procedure and apparatus are discussed in detail. The reducing re-extraction of plutonium with $U(SO_4)_2$ takes place in a mixing-decanting train of 10 stages, 8 of which are for reduction and re-extraction and 2 steps being for removing the aqueous phase containing the plutonium from the solvent by washing. (W.L.H.)

4011 (CEA-tr-A-715) ETUDE DES PROPRIÉTÉS ÉCHANGEUSES D'IONS DES COMPOSÉS MINÉRAUX DE L'ÉTAIN ET DU ZIRCONIUM À L'AIDE DES ISOTOPES TRACEURS. (Study of the Ion Exchange Properties of Mineral Compounds of Tin and Zirconium Using Isotope Tracers). E. Merz. Translated into French from Z. Elektrochem. 63, 288-92(1959). 16p.

Inorganic ion-exchange materials offer several advantages, including resistance to radiation and heat, which make them more suitable for applications in the nuclear industry for moderator and coolant processing and nuclear-fuel reprocessing. A study was made of the preparation and properties of zirconium and tin phosphates as ion exchangers. (T.R.H.)

4012 (CEA-tr-R-296) MESURE DE LA TENSION DE VAPEUR DE L'OXYDE DE BÉRYLLIUM EN ÉQUILIBRE

AVEC L'OXYDE SOLIDE. (Measurement of the Pressure of Beryllium Oxide Vapor in Equilibrium with Solid Oxide). L. P. Belykh and A. N. Nesmeianov (Nesmeianov). Translated into French by B. de Trezvinsky from Doklady Akad. Nauk. S.S.S.R. 128, 979-80(1959). 8p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 2379.

4013 (CEA-tr-R-915) ETUDE DES OXYDES NATURELS D'URANIUM À L'AIDE DE RAYONS X. (Study of the Natural Oxides of Uranium by X Rays). G. A. Sidorenko. Translated into French by B. Vinogradoff from Geokhimiya No. 1, 22-38(1958). 32p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, abstract No. 16860.

4014 (CEA-tr-R-920) FORMATION DE COMPLEXES DE FLUORURES DES MÉTAUX ALCALINS AVEC LES MÉTAUX DU QUATRIÈME GROUPE. (Formation of Complexes of Alkali Metal Fluorides with Metals of the Fourth Group). E. P. Dergunov and A. G. Bergmann. Translated into French from Doklady Akad. Nauk S.S.S.R. 60, 391-4 (1948). 8p.

An explanation is offered for experimental data obtained on alkali metal fluorides and group IV fluorides, conforming to theoretical ideas on the structure and stability of complex compounds of the double-salt type. Results are also given from a study of the ternary system KF–RbF–ThF_4 in which the division of the base triangle into simple compounds is done not only by phase triangles but also by phase tetragons. (tr-auth)

4015 THE AMMONOLYSIS OF ZIRCONIUM(IV) CHLORIDE. J. E. Drake and G. W. A. Fowles (The University, Southampton, Eng.). J. Less-Common Metals 2, 401-3(1960) Oct. (In English)

Tensimetric studies made by Fowles and Pollard showed that one mole of NH_4Cl was formed in the reaction of $ZrCl_4$ with ammonia at –63 and –36°C. Although these experiments suggested the formation of $ZrCl_3(NH_2)\cdot XNH_3$, this compound was not isolated. Removal of NH_4Cl from the products of the ammonalysis of $ZrCl_4$ did not effect a greater replacement of chlorine atoms, and the ammonobasic zirconium(IV) chloride predicted in tensimetric experiments was isolated in almost quantitative yield. (M.C.G.)

4016 SECOND VIRIAL COEFFICIENTS OF NEON, ARGON, KRYPTON AND XENON WITH A GRAPHITIZED CARBON BLACK. J. R. Sams, Jr., G. Constabaris, and G. D. Halsey, Jr. (Univ. of Washington, Seattle). J. Phys. Chem. 64, 1689-96(1960) Nov.

Precise measurements of the adsorption of neon, argon, krypton, and xenon on the highly graphitized carbon black P33 (2700°) at coverages of less than 10% of the monolayer are reported. These data were analyzed in terms of a virial coefficient treatment to yield interaction energies and apparent areas. Several models for the interaction potential were investigated, but no definite choice of a model can be made on the basis of these data. Various theories for obtaining the area from the data are discussed and compared with the usual BET method for determining the area of the black. Values for the isosteric heats of adsorption at zero coverage are also discussed. (auth)

4017 THE EXCHANGE OF Li^+, Na^+ AND K^+ WITH H^+ ON ZIRCONIUM PHOSPHATE. Edwin M. Larsen and Donald R. Vissers (Univ. of Wisconsin, Madison). J. Phys. Chem. 64, 1732-6(1960) Nov.

The equilibrium exchange of Li^+, Na^+, and K^+ with the hydrogen form of zirconium phosphate in 0.1005N HCl was studied over the temperature range 1.17 to 44.5°. The following data were obtained for Li^+, Na^+, and K^+, respectively: ΔF^0 +2.0, +1.1, +0.56 kcal/mole; ΔH^0 0.0, –2.7, –5.7 kcal/mole and ΔS^0, –6.7, –13, –21 eu. (auth)

4018 ISOTOPE EFFECTS IN $Hg(6^3P_1)$-PHOTOSENSITIZED REACTIONS: $H_2 + N_2O$ AND $H_2 + NO$. Morton Z. Hoffman and Richard B. Bernstein (Univ. of Michigan, Ann Arbor). J. Phys. Chem. 64, 1753-6(1960) Nov.

The N^{14}/N^{15} and O^{16}/O^{18} isotope effects in the $Hg(6^3P_1)$-photosensitized (MPS) reaction of hydrogen with nitrous oxide and with nitric oxide were measured. In the MPS reaction of $N_2O + H_2$, the N^{14}/N^{15} isotope effect was independent of the ratio $(H_2)/(N_2O)$ over the range 1.0 to 12, with an average value of $S^0 = 1.018 \pm 0.001$ compared with $S^0 = 1.017 \pm 0.001$ for the MPS decomposition of N_2O. The O^{16}/O^{18} isotope effect was 1.017 ± 0.002 compared with 1.019 ± 0.001 for the decomposition. These observations imply that the rate of hydrogen-atom attack on N_2O is a small fraction of the rate of the N_2O decomposition. In the MPS reaction of $NO + H_2$, the N^{14}/N^{15} isotope effect was found to be "inverted," the first fraction of N_2 produced was enriched in N^{15} relative to the original NO. At a ratio $(H_2)/(NO) = 1.0$, the fractionation factor was 1.008, diminishing to the null value of 1.000 at a ratio of 29. The N^{15} enrichment is interpreted on the basis of a postulated isotope exchange equilibrium between NO and HNO. (auth)

4019 THE HEAT OF COMBUSTION OF LUTETIUM. Elmer J. Huber, Jr., Earl L. Head, and Charles E. Holley, Jr. (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem. 64, 1768-9(1960) Nov.

The heat of combustion of lutetium metal was measured by a method involving the determination of the heat evolved from the combustion of a weighed sample of the metal in a bomb calorimeter at a known initial pressure of oxygen. Two series of runs gave values of 5290.5 ± 11.05 and 5269.7 ± 5.2 joules/g for the heat of combustion. (M.C.G.)

4020 THE $Hg(6^3P_1)$-PHOTOSENSITIZED DECOMPOSITION OF NITRIC OXIDE. Morton Z. Hoffman and Richard B. Bernstein (Univ. of Michigan, Ann Arbor). J. Phys. Chem. 64, 1769-71(1960) Nov.

The rate of formation of nitrogen in the $Hg(6^3P_1)$-photosensitized decomposition of nitrogen oxide in the pressure range 174 to 676 mm Hg was determined. The N^{14}/N^{15} isotope effect in the reaction was also measured. Implications of the present results regarding the mechanism of nitrogen production are discussed. (M.C.G.)

4021 THE POLARIZABILITY OF RADON. D. G. Tuck (Univ. of Nottingham, Eng.). J. Phys. Chem. 64, 1775-6(1960) Nov.

A value of 6.3 A was derived for the polarizability of the radon atom. Using the value for the heat of adsorption of radon on charcoal, the polarizability was determined from the equation $\Delta H = 0.29 + 2.11\ \alpha$, where ΔH is heat of adsorption and α is polarizability. (M.C.G.)

4022 SOLAR FURNACE DETERMINATION OF HIGH-TEMPERATURE ABSORPTION COEFFICIENTS. R. G. Struss (Sandia Corp., Albuquerque, N. Mex.). Solar Energy 4, No. 2, 21-6(1960) Apr. (SCR-189).

Recent experiments demonstrate that a solar furnace serves as an excellent tool for establishing heat-absorption coefficients of materials at extremely high temperatures. An outline of experiments with naval brass (60.4% Cu, 39.6% Zn) illustrates the general method used. A sample

was soaked at 1575°F and quenched in an ice bath so that the single-phase β structure could be retained. The sample was then exposed in the furnace for 1.7 sec and sectioned, polished, etched, and photographed. The ASM Metals Handbook gave the melting point at the exposed face, 1645°F, the temperature between the single-phase and two-phase regions near the exposed face, 1400°F, and the temperature between the two-phase region and the original structure, 675°F. The solar energy incident on the earth was calculated by calorimetry to be 1.9 cal/cm^2/min. The McAdams equation is used for calculating the temperature profile of a semi-infinite solid by rapid heating for a short period. With a furnace efficiency of 30% the absorption coefficient for brass is 0.17. (auth)

4023 INTERACTION OF URANIUM-CONTAINING MOLTEN HALIDE SALT MIXTURES WITH BISMUTH. I. F. Nichkov, S. P. Raspopin, and Yu. V. Bazhkov. Zhur. Priklad. Khim. 33, 2136-9(1960) Sept. (In Russian)

Following up previous findings, according to which thorium, zirconium, titanium, and beryllium are dissolved in molten alkali metal chlorides under formation of either alkali metal suboxides or of alloys, the interaction of metallic bismuth with molten mixtures containing UCl_4 + NaCl, LiCl, or $CaCl_2$ was investigated, including also a study of the effect of LiF and CaF_2 additions to the above mixtures. It was found that the uranium does not precipitate out on the surface of the metallic bismuth but passes into the black residue which contains 41.6 to 77.3 wt. % uranium, 2.5 to 8.5 wt. % bismuth, and 2 to 16 wt. % alkali metal. The components form an actual compound rather than a mixture of distinct phases, according to the x-ray-diffraction analysis. An equivalent amount of bismuth was dissolved by the melt. The compound was found to be insoluble in the molten salt mixture or in molten bismuth. The reaction is given by the following expression: $3\ U^{4+} + Bi \rightarrow 3\ U^{3+} + Bi^{3+}$. The deposit seems to hinder the formation of a U–Bi alloy. (TTT)

Radiation Chemistry and Radiochemistry

4024 (AD-148059) PREPARATION OF FLUOROCHEMICALS BY RADIATION INDUCED CROSS-FLUORINATION. Technical Report covering the Period September 16, 1956–September 15, 1957. P. Y. Feng and C. A. Stone. Illinois Inst. of Tech., Chicago. Armour Research Foundation. Dec. 2, 1957. 47p. Project No. A-093. [Contract AF18(603)-121]. [(AFOSR-TN-58-20)].

The radiation behavior of a number of fluorine compounds, including CF_4, CHF_3, CF_2Cl_2, $CFCl_3$, $C_2F_4Cl_2$, C_6H_5F, and $C_6H_5CF_3$, in the presence of benzene and other organic compounds was studied. Diphenyl picryl hydrazyl disappearance and polymer degradation experiments showed that the fluorine compounds studied have considerably lower radiation sensitivities than the corresponding chlorine or bromine compounds. Irradiation of solutions of the fluorocarbons in benzene produced aromatic fluorine compounds with a total G value up to approximately 3 in the more favorable cases in spite of the known stability of fluorocarbons toward attack by radicals. On the basis of the radical yield data, it was concluded that free-radical reactions cannot be responsible for the formation of all of the fluorinated aromatic compounds. Ion-molecule reactions in the liquid state are suggested as a possible contributing factor to the observed reaction results. (auth)

4025 (AERE-C/R-1575(1-6)(Suppl. 4)) SELECTED ABSTRACTS OF ATOMIC ENERGY PROJECT UNCLASSIFIED REPORT LITERATURE IN THE FIELD OF RADIATION CHEMISTRY AND BIBLIOGRAPHY OF THE PUBLISHED LITERATURE 4th ANNUAL SUPPLEMENT (PAPERS NOTED UP TO DECEMBER 1959). R. W. Clarke, comp. (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 1960. 503p. BIS.

This bibliography contains 2272 references to report and published literature on radiation chemistry, including dosimetry and facilities. Author and subject indexes are included. (J.R.D.)

4026 (ARL-TN-60-139) RADIATION CHEMISTRY OF N-PENTANE: MECHANISM FOR THE FORMATION OF LOWER MOLECULAR WEIGHT PRODUCTS. Jean H. Futrell (Wright Air Development Center. Aeronautical Research Lab., Wright-Patterson AFB, Ohio). Aug. 1960. 16p. Project 7021.

Pyrex ampoules of n-pentane vapor were exposed to Co^{60} γ rays and 100-ev. Yields of the lower molecular weight products (ethylene, ethane, methane, propylene, acetylene, and butane) were tabulated. The magnitude of the yields and the product distribution are consistent with the assumption that the reaction sequence is ionization of the molecule, fragmentation, reaction of the fragment ions with pentane molecules, and neutralization of the product ions, followed by intercombination of free radicals from these processes. Certain implications of this mechanism are suggested. (auth)

4027 (NP-9387) DUKE MICROWAVE LABORATORY REPORT NO. 30 FOR MAY 1, 1960–AUGUST 1, 1960. (Duke Univ., Durham, N. C.). 95p. Project No. R-357-10-6. Contract AF18(600)-497.

The structure and orientation of free radicals formed by ionizing radiations in certain native proteins were investigated. Temperature effects were investigated on free radical formation and electron migration in irradiated proteins. The electron spin resonance of an irradiated single crystal of n-acetylglycine was studied. (W.L.H.)

4028 (NYO-9104) A STUDY OF THE MECHANISM OF RADIATION INDUCED GELATION IN MONOMER-POLYMER MIXTURES. Quarterly Summary Report [for] May 9, 1960 to July 31, 1960. (Radiation Applications Inc., Long Island City, N. Y.). Sept. 20, 1960. 7p. Contract AT(30-1)-2554. OTS.

A number of mixtures of polymers and multi-unsaturated monomers were prepared and irradiated. The content of insoluble gel of irradiated samples of these polymer-monomer mixtures was determined by extraction. (auth)

4029 (RRL-45) QUARTERLY REPORT [FOR] JULY 1, 1960–SEPTEMBER 30, 1960. Fundamental Research No. 205. Mellon Inst. Radiation Research Labs., Pittsburgh. Oct. 21, 1960. 10p. Contract AT(30-1)-2310. (NYO-9164). OTS.

Investigations in progress include those on methyl radical production in the radiolysis of hydrocarbons, radiation chemistry of neopentane, radiolysis of liquid ethane and butyl chlorides, methods for use in examining free-radical species by paramagnetic resonance, use of tritium iodide as a radical scavenger, production of negative ions, and radiation effects in solids. (J.R.D.)

4030 (TID-6780) THE EFFECT OF GAMMA RADIATION ON CHEMICAL REACTIONS. A Collection of material originally presented as part of the Progress Reports

of the Fission Products Laboratory from 1951 to 1955. (Michigan. Univ., Ann Arbor. Engineering Research Inst.). June 1956. 219p. Contract AT(11-1)-162. (ERI-1943-4-70-T). OTS.

A collection of material that was originally included in progress reports of the Fission Products Laboratory from 1951 to 1955 is presented. Sections are included from seven progress reports. These sections deal with literature surveys concerning radiation effects on chemical reactions, summaries of work on γ-promoted polymerization, and other radiation-promoted chemical reactions. (J.R.D.)

4031 (TID-11031) RADIATION CHEMISTRY: REACTIONS INDUCED BY LOW ENERGY ELECTRONS. Period covered: February 1, 1960–October 31, 1960. Russell R. Williams, Jr. (Haverford Coll., Haverford, Penna.). Nov. 1, 1960. 11p. Contract AT(30-1)-2357. OTS.

The hydrocarbon products resulting from low-energy electron irradiation of methane have been examined in detail. A typical result is C_2H_6, 81%; C_3H_8, 15%; i-C_4H_{10}, 1.7%; n-C_4H_{10}, 1.1%; i-C_5H_{12}, 0.4%; n-C_5H_{12}, 0.1%; and neo-C_5H_{12}, 0.1%. Aside from minor trends in composition this result is independent of applied voltage (electron energy), gas pressure, extent of decomposition, and light intensity. It would thus appear that the whole product spectrum is due to excitation rather than ionization. (auth)

4032 (CEA-tr-R-914) COPRÉCIPITATION DES RADIOÉLÉMENTS AVEC DES DEPOTS CRISTALLINS. (Coprecipitation of Radioelements with Crystalline Deposits). M. C. Merkulova. Translated into French from Zhur. Neorg. Khim. 3, 25-8(1958). 10p.

A study was made of the phenomenon of coprecipitation of bivalent metal ions with salts of the NaCl type. The mechanism of penetration of these ions in crystalline lattices is still not clear. The isotopes Pb^{210}, Pb^{212}, and Sr^{89} were used in the aqueous systems NH_4I–PbI_2, NaCl–$PbCl_2$, and NaCl–$SrCl_2$. The results of the various experiments show that this is a new type of coprecipitation. The ion penetration seems to occur in two steps: formation of substitute solid solution with limited solubility and, when concentrations exceed the miscibility limit, formation of adsorption systems. (T.R.H.)

4033 (CEA-tr-R-1001) ETAT DES MICROQUANTITÉS DE RADIOÉLÉMENTS DANS LES SOLUTIONS. XII. ETUDE DE L'ÉTAT DU POLONIUM DANS LES SOLUTIONS AQUEUSES, PAR LA MÉTHODE ÉLECTROCHIMIQUE. (State of Microquantities of Radioelements in Solution. XII. Study of the State of Polonium in Aqueous Solution by the Electrochemical Method). I. E. Starik and N. I. Anpelogova. Translated into French by G. Meyer from Radiokhimiya 1, 419-24(1959). 16p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 5147.

4034 (UCRL-Trans-605) THE DIRECT EFFECT OF X-RAYS ON PROTEINS, PEPTIDES AND AMINO ACIDS. I. EXAMINATION OF PROTEINS: IRRADIATION OF LYSOZYME. Antonio Caputo and Klaus Dose. Translated from Z. Naturforsch. 12b, 172-80(1957). 14p. JCL.

The primary effect of x irradiation (doses from 2 to 30 million r) on crystalline lysozyme has been investigated by the use of physico-chemical (electrophoresis and ultracentrifugation), chemical, and biological methods. It was found that radiation produced a range of similar but less basic proteins of different molecular weights and that the amino acid composition of the protein was partially changed in regard to its chemical bonds. Upon comparing the terminal amino and carboxyl groups of the amino acids of the irradiated protein with lysozyme itself, differences were found only in the terminal carboxyl groups. The biological activity of this protein remained practically unchanged even after irradiation with 5 million r. (auth)

4035 THE RADIOLYSIS OF LIQUID n-HEXANE. Thomas J. Hardwick (Gulf Research and Development Co., Pittsburgh). J. Phys. Chem. 64, 1623-31(1960) Nov.

The continuous decrease in hydrogen gas yield during the radiolysis of n-hexane is attributable to the addition of hydrogen atoms to the hexenes concurrently being produced. Unsaturation in the C_7–C_{12} products arises from the addition reaction of alkyl plus alkenyl radicals. The alkenyl radicals are derived from hydrogen abstraction from hexenes by hydrogen atoms. The over-all kinetics of radiolysis are satisfactorily explained by invoking free radical mechanisms. Ion–molecule reactions appear to play little or no part. Both "hot" and thermal hydrogen atoms are produced, the former invariably forming hydrogen gas. An explanation for the mechanisms of formation of the so-called "molecular" products is given. The yield of products can be explained quantitatively by a relatively simple reaction scheme. (auth)

4036 GAS PHASE RADIOLYSIS OF n-PENTANE. Jean H. Futrell (Aeronautical Research Lab., Wright-Patterson AFB, Ohio). J. Phys. Chem. 64, 1634-6(1960) Nov.

Pyrex ampoules of n-pentane vapor were exposed to Co^{60} γ rays and 100-ev yields of the lower molecular weight products were determined. In decreasing order of importance these included hydrogen, propane, ethylene, ethane, methane, propylene, acetylene, and butane. The magnitude of the yields and the product distribution were consistent with the assumption that the reaction sequence is ionization of the molecule, fragmentation, reaction of the fragment ions with pentane molecules, and neutralization of the product ions, followed by intercombination of free radicals from these processes. Certain implications of this mechanism are suggested. (auth)

4037 THE EFFECTS OF X-RAY AND GAMMA RAY IRRADIATION ON THE THERMAL DECOMPOSITION OF AMMONIUM PERCHLORATE IN THE SOLID STATE. Eli S. Freeman, David A. Anderson, and Joseph J. Campisi (Picatinny Arsenal, Dover, N. J.). J. Phys. Chem. 64, 1727-32(1960) Nov.

The effect of exposure of ammonium perchlorate to x and γ radiation on its chemical reactivity with respect to thermal decomposition was investigated. The course of the reaction was followed by differential thermal analysis and by thermogravimetric experiments conducted under ambient and reduced pressures. Decomposition was also studied by microscopic observations. The data show that several stages of reaction are involved in the decomposition of ammonium perchlorate and that the low temperature stages are appreciably enhanced as a result of preirradiation. The relative importance of the various stages of reaction were found to be a function of the exposure dose. Although direct evidence is lacking, it is suggested that the increased reactivity of the irradiated substance may be due to the presence of positive holes which would favor an electron transfer mechanism of decomposition. The effect of impurities such as Ag^+, Cu^{++}, and I^- ions on decomposition seem to support the suggested mechanism. The decomposition pattern of samples exposed to γ rays is similar to that of the x-ray irradiated ammonium perchlorate. (auth)

4038 EFFECTS OF IONIZING RADIATION ON AQUEOUS SOLUTIONS OF INOSINE AND ADENOSINE. G. Hems (Royal Cancer Hospital, London). Radiation Research 13, 777-87(1960) Dec.

When aqueous solutions of inosine, adenosine, guanosine, and xanthosine are irradiated with 15-Mev electrons in the absence of oxygen, the main reaction is opening of the imidazole ring to form the corresponding formamidopyrimidine. The sugar moiety is attacked to a lesser extent and is followed by release of free base. When oxygen is present during irradiation the amount of nucleoside destroyed is two to three times as great as in the absence of oxygen. The increased destruction is due almost entirely to an increased base attack. After irradiation in the presence of oxygen no UV-absorbing product arising from base attack is found, and the reaction in oxygen seems to be qualitatively different from the reaction in the absence of oxygen. These reactions are not confined to nucleosides but occur with nucleotides and at least one base, adenine. It is suggested that, if a radiobiological change is enhanced by the presence of oxygen during irradiation and is also produced by an alkylating agent, then attack on the guanine moiety may be the initial chemical lesion. (auth)

4039 THE MECHANISM OF ACTION OF AET. I. THE RADIATION CHEMISTRY OF 2-MERCAPTOETHYLGUANIDINE AND BIS-(2-GUANIDOETHYL) DISULFIDE IN AQUEOUS BUFFERED SOLUTIONS. Bernard Shapiro and E. Anne Dickens (Albert Einstein Medical Center, Philadelphia). Radiation Research 13, 857-70(1960) Dec.

Aqueous buffered solutions of MEG and GED were irradiated by means of a 3-c Co^{60} γ-ray source. The radiation products were separated and identified by paper chromatography and electrophoresis. Irradiation of solutions of MEG produced GED. Irradiation of solutions of GED produced 2-guanidoethanesulfinic acid, taurocyamine, inorganic sulfate, and guanidine. G values were calculated for the oxidation of MEG at pH 6 (14.3 to 18.2), for the oxidation of GED at pH 7.5 (0.29) and at pH 8.5 (1.0), for the formation of 2-guanidoethanesulfinic acid plus taurocyamine at pH 7.5 (0.42), and for the formation of inorganic sulfate and guanidine at pH 7.5 (0.17). The oxidation of MEG and GED by ionizing radiation indicated that these protective agents were capable of reacting with oxidizing free radicals formed in irradiated aqueous solutions. (auth)

4040 ELEMENTARY PROCESSES IN ACTION OF IONIZING RADIATION. John L. Magee (Univ. of Notre Dame, Ind.). p.130-50 of "Comparative Effects of Radiation." Milton Burton, J. S. Kirby-Smith, and John L. Magee, eds. New York, John Wiley & Sons, Inc., 1960.

The elementary processes that determine the initial distributions of chemically reactive intermediates in a condensed molecular system are discussed, especially in the case of low linear-energy-transfer radiations with so-called spurs. The migration of electronic excitation energy is covered theoretically with a quantum mechanical treatment of the linear model of coupled systems, and graphs are presented illustrating how the excitation spreads along a coupled linear chain with time. The parameter determining the spreading velocity is β, the resonance integral between neighboring units in the chain. The factors setting the value of β are discussed. Dissociation processes are next treated, and the influence of coupling on these processes is studied with a model of a linear chain of coupled diatomic molecules, from which it is concluded that it is difficult for a strongly coupled system to find a dissociation mechanism. Localized electronic excitation is then studied for singlet and triplet states, and the fraction of triplet states formed on electron recapture is calculated as a function of spur size. Other possible ways of forming localized states are considered. Finally, factors determining the size and geometry of spurs are discussed. (D.L.C.)

4041 RADIATION CHEMISTRY OF WATER. C. J. Hochanadel (Oak Ridge National Lab., Tenn.). p.151-89 of "Comparative Effects of Radiation." Milton Burton, J. S. Kirby-Smith, and John L. Magee, eds. New York, John Wiley & Sons, Inc., 1960.

A general survey is presented on the radiation chemistry of water irradiated with ionizing radiations and the principles that have been developed. A list of most of the possible radiolytic reactions is given together with a time scale for these reactions and subsequent events, but most results can be correlated assuming decomposition only to H and OH. Experimental evidence for chemical intermediates is reviewed. The geometry and distribution of the products of the primary events are discussed, and the role of diffusion in the reactions is treated. Work performed on radiolysis of pure water and solutions (Fe^{2+} and Ce^{4+}) are reviewed; and the effects of concentration, linear energy transfer, pH, isotope (D_2O), and temperature on the radiolytic yields are studied. Ice and frozen solutions are also considered. (D.L.C.)

4042 DIRECT AND INDIRECT EFFECTS ON CHEMICAL SYSTEMS. William H. Hamill (Univ. of Notre Dame, Ind.). p.190-213 of "Comparative Effects of Radiation." Milton Burton, J. S. Kirby-Smith, and John L. Magee, eds. New York, John Wiley & Sons, Inc., 1960.

A discussion of chemical evidence for irradiated liquid systems is presented in terms of dissociative electron attachment, charge exchange, and ion-molecule reactions together with data for the gaseous products of γ irradiations of binary mixtures of cyclohexane with methyl iodide, chloroform, and benzyl acetate. A plot of $G(H_2)$ vs. log electron fraction of additive to cyclohexane is nearly linear for all the additives, and $G(CH_4)$ for solutions containing methyl iodide is very nearly the complement of $G(H_2)$ for the same solutions. G(HCl) for chloroform is similar to $G(CH_4)$ for methyl iodide. Various possible mechanisms for these reactions are discussed. (D.L.C.)

Raw Materials and Feed Materials

4043 (MCW-1459) PROCESS DEVELOPMENT QUARTERLY PROGRESS REPORT [FOR] JULY–SEPTEMBER 1960. Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo. Nov. 1, 1960. 90p. Contract W-14-108-Eng-8. OTS.

Laboratory investigation of the extraction of molybdenum by 30% TBP-hexane has continued. Factors affecting the formation and extraction of molybdenum heteropoly acids are discussed, and differences in the extraction of molybdenum from feed concentrates are explained. Reliable operation of the fluid-bed denitrator was demonstrated for 14 weeks during the production of UO_3 for plant testing. Sustained operation at rates above 400 lb UO_3/hr-sq ft was also demonstrated. The flame-denitration reactor has been modified to improve operability. The major problem remaining is deposition of solids on the reactor walls. Recent progress in the development of the electrolytic process for producing uranium metal directly from uranium dioxide is

reported. Massive, high-quality metal in pieces as large as 6800 grams has been produced. Factors affecting the design and operation of the electrolytic cell are also discussed. An inexpensive laboratory gas-chromatograph has been set up to determine N_2, CO, CO_2, O_2, and CF_4 in by-product off-gas from the electrolytic reduction of uranium dioxide to uranium metal. Single-pass operation of the fluid-bed hydrofluorinator has produced maximum green salt assays of above 90% UF_4. Two-pass operation produced UF_4 of acceptable AOI content. A new reactor has been planned to operate in series with the existing unit. The use of a phosphoric acid dissolution procedure has been shown to shorten materially the time required for the determination of tetravalent uranium in uranium tetrafluoride without loss of accuracy or precision. The precision at the 95% confidence level was found to be ±0.084% absolute. A rapid method has been developed for the estimation of ammonium oxalate-insoluble material from its effect on the diffuse reflectance spectrum of uranium tetrafluoride. Measurements can be obtained within about 5 minutes with a precision of ±0.4% absolute at the 95% confidence limit. Further development of an extrusion process for HAPO-type I & E cores has demonstrated the feasibility of extruding reactor-grade material from production-size billets using the Weldon Spring press. X-ray evaluation of α-extruded, β-heat-treated dingot-uranium cores produced in the seventh α-extrusion campaign has indicated near-random orientations. Growth indices are very similar to those observed at the Hanford Atomic Products Operation for cores with other fabrication histories. (auth)

4044 (NP-9396) RESEARCH AND DEVELOPMENT QUARTERLY REPORT FOR JULY–SEPTEMBER 1960. Eldorado Mining and Refining Ltd. Research and Development Div., Port Hope, Ont. 15p. (R60-3).

In the solvent-in-pulp program some continuous test work was carried out using desanded leach slurries. The apparatus performed smoothly but extraction was poor, apparently largely as a result of short-circuiting between stages. An improved system of baffles has been devised to prevent serious short-circuiting, but resumption of continuous tests has been delayed to allow for completion of further batch work. Mixing studies on a kerosene–water system were conducted on a relatively large scale using batch equipment provided by Greey Mixing Company. Conditions were established for pilot-scale continuous stripping of amine extracts with strong sulfuric acid. Stripping was satisfactory only when the aqueous phase was maintained continuously in the mixers. An outline is presented of various approaches to the problem of vanadium removal from Beaverlodge solution and precipitate. (auth)

4045 PHYSICAL PROCESSING OF URANIFEROUS ORES. E. Roques (Commissariat à l'Energie Atomique, Saclay, France). Rev. ind. minérale 42, 11p.(1960) June. (In French)

A method of processing is presented for use with the minerals of certain altered deposits containing a high percentage of partially altered neoformation products in surface regions. Flotation and gravimetric methods are too costly and inefficient, but grinding in rotating drums forms the basis of an efficient and economical method. The cycle envisaged is relatively simple and makes use of radiometric sorting. After a discussion of flotation, gravimetric methods, radiometric concentration methods, and grinding methods, the ores of Brugeauds and Sagnes are described, and results of grinding tests are given. The Bessines grinding-washing plant incorporating the recommended procedures is described. (T.R.H.)

Separation Processes

4046 (IDO-14525) SALT-PHASE CHLORINATION OF REACTOR FUELS. II. ARCO PROCESS DEFINITION AND SCOPING STUDIES. E. M. Vander Wall, H. T. Hahn, and D. L. Bauer. Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho. Oct. 20, 1960. 41p. Contract AT(10-1)-205. OTS.

The dissolution of reactor fuel alloys in molten chlorides is described. The basic ARCO process was investigated principally as a head-end treatment of zirconium–uranium alloys. The alloy is rapidly dissolved in molten lead chloride at 520°C, and zirconium is simultaneously volatilized as the tetrachloride. Uranium is recovered from the salt matrix by leaching with 8M nitric acid. Leach chloride is regenerated by either dissolution of lead in nitric acid followed by metathesis with hydrochloric acid or by direct chlorination. Several nickel alloys displayed reasonably low corrosion resistance in the lead–lead chloride system. The process promises to be economically competitive with other zirconium fuel processes and at the same time exhibits several advantages, such as rapid but controlled reaction rates, freedom from fluoride ion and recycling gases, appreciably smaller final uranium decontamination equipment, and immediate separation of zirconium as a dry compact waste. Tentative flowsheets for a 5 kg/day uranium plant are presented. Modification to include direct chlorination of fuel in the dissolver vessel is shown to dissolve stainless steel and most other fuel component metals at practical rates. In this case the fused chloride serves as a medium to remove the reaction heat and nonvolatile reaction products. (auth)

4047 (IDO-14528) DENSITIES OF AMMONIUM FLUORIDE–AMMONIUM NITRATE–AMMONIUM HEXAFLUOZIRCONATE SOLUTIONS. J. L. Teague and D. P. Pearson. Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho. Oct. 27, 1960. 15p. Contract AT(10-2)-205. OTS.

The densities of various Zirflex-type solutions at 25°C can be expressed by the equation: ρ calc = (0.99710 + 0.03157 m) + (0.02046 − 0.002659 m)c − (0.003346 − 0.000703 m)$c^{3/2}$ + 0.14349x + 0.49z where m = moles liter^{-1} NH_4NO_3, c = moles liter^{-1} NH_4F, x = moles liter^{-1} $(NH_4)_2ZrF_6$, and z = moles liter^{-1} $UO_2(NO_3)_2$. This equation fits the data with a sigma value of 0.00018 g/ml for NH_4F-NH_4NO_3 solutions, 0.00024 g/ml for NH_4F-$(NH_4)_2ZrF_6$ solutions, and 0.0002 g/ml for solutions containing $UO_2(NO_3)_2$ and/or NH_4F-NH_4NO_3 over the range of 0.0M to 6.0M NH_4F, 0.0M to 1.6M NH_4NO_3, 0.0M to 0.5M $(NH_4)_2ZrF_6$, and 0.0M to 0.0025M $UO_2(NO_3)_2$. (auth)

4048 (ORNL-1208(Del.)) RECOVERY OF NITROGEN OXIDES AND RARE GAS FISSION PRODUCTS FROM THE NITRIC ACID DISSOLUTION OF IRRADIATED URANIUM. A. T. Gresky (Oak Ridge National Lab., Tenn.). Apr. 30, 1952. Decl. with deletions Feb. 9, 1960. 83p. Contract W-7405-eng-26. OTS.

Procedures for the handling and recovery of nitrogen oxides and rare-gas fission products from the nitric acid dissolution of irradiated uranium are described. (C.J.G.)

4049 (ORNL-2940) CHEMICAL TECHNOLOGY DIVISION ZIRFLEX PROCESS FOR PWR BLANKET FUEL. II. REVISED FLOWSHEET. L. M. Ferris. Oak Ridge National Lab., Tenn. Nov. 9, 1960. 24p. Contract W-7405-eng-26. OTS.

A revised Zirflex process is presented for dissolution of Shippingport Pressurized Water Reactor blanket fuel (UO_2

pellets clad in Zircaloy-2). The Zircaloy-2 is dissolved in 6 M NH_4F – 1.0 M NH_4NO_3 and the core in 10 M HNO_3 – 0.1 M $Al(NO_3)_3$. It differs from the original in dilution of the decladding solution to about 0.1 instead of 0.5 M zirconium and addition of 0.1 M $Al(NO_3)_3$ to the core dissolvent to inhibit corrosion by fluoride sorbed on the pellets. Use of a down-draft condenser during the decladding is suggested to prevent return of NH_4OH to the dissolver, thereby avoiding formation of insoluble $ZrO_2 \cdot 2H_2O$. Two types of flowsheet demonstration experiments were performed: batch dissolutions of single unirradiated blanket rods and a series of successive dissolutions in which half a fuel rod was added at the start of each cycle and undissolved zirconium was allowed to accumulate. In 3 hr about 80% of the zirconium in a nonoxidized rod dissolved in boiling 6 M NH_4F – 1 M NH_4NO_3 (fluorine to total zirconium mole ratio of 6), leaving only the solid end caps. The soluble uranium loss was less than 0.07%. No precipitation occurred when the decladding solution was diluted to 0.1 M zirconium. When the surface of the zirconium had been oxidized, decladding required as long as 17 hr. In the series of successive dissolutions, the amount of undissolved zirconium increased with increasing number of cycles until it reached what appeared to be a steady-state amount after about 15 cycles. The steady-state amount of zirconium residue was roughly equal to the amount charged to the dissolver at the beginning of each cycle. The solubilities of ZrF_4 in NH_4F-HNO_3 solutions and of UO_2F_2 in NH_4F solutions were determined. (auth)

4050 (RCN-1) THE MECHANISM OF SULFURIC ACID AND URANIUM EXTRACTION BY TERTIARY AMINES (thesis). Judicus Marinus Pieter Jan Verstegen (Reactor Centrum Nederland, Hague). 1960. 122p.

Submitted to the Amsterdam. Universiteit.

Results are reported of investigations concerning the extraction by tri-n-hexyl amine and tri-n-octyl amine, the first mostly used together with a salting-out agent. The mechanism of the reaction between amine and sulfuric acid depends strongly on the solvent used. When benzene was used, the law of mass action seemed to be followed. When kerosene was used, formation of micelles was probable. The uranium extraction depends on the sulfuric acid loading of the organic phase, and it is concluded that several complexes between amine sulfate and uranyl sulfate exist. A synopsis is given of literature on extraction. (auth)

4051 (TID-6980) DEVELOPMENT OF SEPARATION PROCEDURES FOR RADIOACTIVE MATERIALS. Annual Technical Status Report No. 1 Covering the Period April 1, 1959 to March 31, 1960. Fred Sicilio (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Apr. 20, 1960. 17p. Project No. A-446-4. Contract AT(38-1)-202. OTS.

Main emphasis was placed on studying the suitability of amalgam-alcohol contact and ion exchange methods for enriching calcium in the Ca^{46} isotope. As yet, no indication of enrichment by either technique has been detected. Calcium-45 was used as a tracer in these studies; the enrichment in Ca^{45} of a spiked calcium sample should be an indication of enrichment in the Ca^{46} isotope. Preliminary studies performed on aqueous-organic extraction systems were discontinued in deference to the amalgam-alcohol system. The aqueous-organic systems involve the extraction of calcium complexed in a large molecule with the resultant masking of any isotopic effect. Techniques for the preparation of calcium amalgams and the counting of Ca^{45} were developed. The standard ethylenediamine tetraacetic acid titration was modified to determine calcium content in a sample. (auth)

4052 (TID-6981) DEVELOPMENT OF SEPARATION PROCEDURES FOR RADIOACTIVE MATERIALS. Quarterly Technical Status Report No. 4 Covering the Period April 1, 1960 to June 30, 1960. Fred Sicilio (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). July 10, 1960. 6p. Project No. A-446-4. Contract AT(38-1)-202. OTS.

A batch type contact study was made with a calcium amalgam phase and a saturated methanolic solution of calcium chloride. Samples from this study are being evaluated by electromagnetic techniques. Alternate analytical schemes are discussed. (auth)

4053 (TID-6982) DEVELOPMENT OF SEPARATION PROCEDURES FOR RADIOACTIVE MATERIALS. Quarterly Technical Status Report No. 5 Covering the Period July 1, 1960 to September 30, 1960. Fred Sicilio (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Oct. 10, 1960. 10p. Project No. A-446-4. Contract AT(38-1)-202. OTS.

The problem of enriching calcium in the Ca^{46} isotope is in a state of reappraisal. The question of establishing the feasibility of embarking on a program of using photochemical excitation and subsequent preferential reaction of a specific calcium isotope must be resolved. The problem of separating barium from strontium by solvent extraction was de-emphasized by the Isotopes Division at ORNL. Preliminary laboratory work will be initiated on checking the applicability of using directly the foam-separation technique for the removal of radioisotopes from radiation-degraded process solvent. A secondary aim of this work will be checking the clean-up of the solvent of radiation-induced decomposition products which impart undesirable solvent-extraction properties to the solvent. (auth)

4054 (TID-11078) THE LOADING AND SEPARATION OF A SOLUTION OF YTTRIUM AND RARE EARTH CHELATES OF ETHYLENEDIAMINETETRAACETIC ACID. Report No. 112. Period covered: July 16 to August 22, 1957. John R. Morton (Michigan Chemical Corp., St. Louis, Mich.). Oct. 25, 1957. Decl. Feb. 6, 1959. 3p. Project No. 942. OTS.

A solution of yttrium and rare earth chelates of ethylenediaminetetraacetic acid was prepared by mixing a hydrochloric acid solution of Lindsay yttrium concentrate with the requisite quantity of 0.5% ethylenediaminetetraacetic acid solution, adjusting to pH 7.5, and loading on coppered columns. Some rare earth leakage was noted due to high pH. Loading was continued until two columns were filled with rare earths, and the rare earths were then eluted through two more columns. Of the total rare earths recovered, no high purity or 99.9% yttrium oxide was produced; 26.9% was 99% yttrium oxide and 15.9% was 95% yttrium oxide. The separation of the small amounts of other rare earths from the yttrium still required two band lengths. (auth)

4055 (TID-11082) THE SEPARATION OF YTTRIUM, TERBIUM, AND GADOLINIUM AT A SELECTED FLOW RATE. Report No. 151. Period covered: October 10, 1957 to November 11, 1957. John R. Morton (Michigan Chemical Corp., St. Louis, Mich.). Apr. 10, 1958. 9p. Project 942. OTS.

The separation of yttrium, terbium, and gadolinium was studied at a flow rate approximately 75% of that normally used. Three 4-in. columns were loaded with a yttrium–terbium–gadolinium concentrate. The rare earths were eluted through two band lengths at the reduced flow rate and collected in 5-gal fractions. The apparent height equivalent

to a theoretical plate was 0.5 in. for the yttrium–terbium overlap and 1.7 in. for the terbium–gadolinium overlap. Of the total amount of yttrium recovered from the columns, 32.3% was 99.9% Y_2O_3, and 39.5% was 99% Y_2O_3. The terbium yield on the above basis was 78.7% as 99.9% Tb_4O_7 and 4.4% as 99% Tb_4O_7. The gadolinium recovered from the run yielded 69.4% of the material as 99% Gd_2O_3. (auth)

4056 (TID-11083) SEPARATION OF YTTRIUM AND THE RARE EARTHS BY LIQUID-LIQUID EXTRACTION. Progress Report No. 167. Period covered: January 16, 1958 to June 6, 1958. David A. Lockwood (Michigan Chemical Corp., St. Louis, Mich.). June 30, 1958. 11p. Project 942. OTS.

The success of the monododecyl phosphoric acid, Dowsol-12 mixture, as an extracting agent for separating yttrium and the rare earths from each other has led to the design of a 70-stage pilot plant liquid-liquid extraction system. A 49-stage unit will be used to separate yttrium and the heavy rare earths from the lights, a 13-stage acid back extractor will separate yttrium from the heavies and an 8-stage acid back extractor will strip the remaining heavies from the organic phase. This report includes information obtained from operation of a 13-stage and 21-stage pilot plant extractor unit and a number of preliminary laboratory experiments. The data reported show that in the 21-stage extractor 85%+ of the total yttrium is upgraded from 63% to 85 to 93%, while dysprosium and gadolinium are reduced to 1400 and 400 ppm, respectively. Recent laboratory experiments indicate that this concentrate can be upgraded by acid back extraction to metallurgical grade yttrium. (auth)

4057 (TID-11084) A STUDY OF THE EFFECT OF SOME VARIABLES ON THE SEPARATION OF YTTRIUM FROM RARE EARTH CONCENTRATES WITH HYDROXYETHYLETHYLENEDIAMINETRIACETIC ACID. Report No. 168. Period covered: November 21, 1957 to April 23, 1958. John R. Morton (Michigan Chemical Corp., St. Louis, Mich.). July 1, 1958. 47p. Project No. 942. OTS.

The effect of four variables (concentration of the eluant, pH of the eluant, band lengths eluted, and flow rate) was studied in connection with the separation of yttrium from the other rare earths. As the concentration of the eluant was increased, the yield of 98% Y_2O_3 and the transport time decreased. The yield of 98% Y_2O_3 increased when the separation was carried through more band lengths while the transport time remained constant. The yield of 98% Y_2O_3 and the transport time decreased with increasing flow-rates. The yield of 98% Y_2O_3 and the transport time decreased with increasing pH of the eluant to a constant minimum value in the range of pH 6.0 to pH 8.0. The best compromise between the maximum production of yttrium and the preparation of the purest yttrium would be the following conditions: A flow-rate of 4.0 ml/cm^2-min, an eluant of pH 6.0, eluant concentration of 3g/l of HEDTA and elution of the rare earths through 1.0 band lengths. The production of high purity yttrium oxide would require a feed containing <0.05% neodymium and low concentrations of terbium, gadolinium and samarium. (auth)

4058 (TID-11087) SEPARATION OF CERIUM FROM THE ORGANIC PHASE IN THE LIQUID-LIQUID EXTRACTION SYSTEM. Report No. 194. Period covered: May 27, 1958 to July 3, 1958. D. McCowen (Michigan Chemical Corp., St. Louis, Mich.). Oct. 28, 1958. 5p. OTS.

The separation of tetravalent cerium from the organic phase of the 21-stage liquid-liquid extraction system was accomplished in a one-stage reactor with a mixture of 1.67% hydrogen peroxide and 0.5 normal sulfuric acid. This separation, which requires 60 min of mixing time, removes up to 99% of the rare earths from the organic phase, leaving the organic mixture clean and ready for reuse. (auth)

4059 (TID-11088) EVALUATION OF THE YORK-SCHEIBEL LIQUID-LIQUID CONTACTOR FOR THE PREPARATION OF A YTTRIUM CONCENTRATE FOR ION EXCHANGE COLUMN FEED. Report No. 195. Period covered: February 26, 1958 to April 16, 1958. John R. Morton (Michigan Chemical Corp., St. Louis, Mich.). 16p. Project 942. OTS.

A maximum separation factor of 40 between yttrium and dysprosium was obtained in a York-Scheibel liquid-liquid contactor containing eleven physical stages using the following solutions and conditions of operation. The organic extractant composition was 2 : 2 : 1 kerosene : Lorol-22(N-decanol) : 25 to 30% monododecyl phosphoric acid in kerosene. The aqueous scrub solution contained 20 g/liter of hydroxyethylethylenediaminetriacetic acid, 24 g/liter of acetic acid, and the pH was adjusted to 4.0 with 28% ammonia. The feed solution contained 50 g/liter of rare-earth oxides dissolved in acetic acid. The feed solution pH was 4.0. The flow rates of the organic extractant, aqueous scrub, and feed solutions were 14.8 ml/min, 8.8 ml/min, and 1.5 ml/min, respectively. The total throughput was 25.1 ml/min. An agitator speed of 700 rpm was used. This separation factor of 40 does not compare favorably with the separation factors (178 to 346) obtained in the 9-stage discontinuous mixer-settler liquid-liquid contactor or the separation factors (70 to 155) that were obtained in the 13-stage continuous mixer-settler liquid-liquid contactor. (auth)

4060 (TID-11094) SEPARATION OF YTTRIUM FROM RARE EARTH CONCENTRATES BY LIQUID-LIQUID EXTRACTION. Report 254. Period covered: September 26, 1958 to December 1, 1958. Patrick A. Lincoln (Michigan Chemical Corp., St. Louis, Mich.). June 23, 1959. 7p. Project 942. OTS.

Rare-earth feed containing 63% yttrium oxide was processed in the 70-stage pilot mixer-settler unit in an attempt to produce a highly concentrated yttrium oxide product. The aqueous feed solution was contacted with an organic phase containing monododecylphosphoric acid and an aqueous scrub containing hydroxyethylethylenediaminetriacetic acid in a 49-stage primary extractor. The yttrium product was then stripped from the organic phase in the 21-stage acid back extractor. The first six runs made with the 63% yttrium oxide feed are covered. The best product obtained in these runs contained 98% yttrium oxide, 0.05% erbium, 0.03% dysprosium, and 0.02% gadolinium. (auth)

4061 (TID-11095) SEPARATION OF YTTRIUM AND THE RARE EARTHS BY LIQUID-LIQUID EXTRACTION. Report No. 255. Period Covered: December 1, 1958 to February 1, 1959 and April 5, 1959 to May 17, 1959. L. D. McCowen (Michigan Chemical Corp., St. Louis, Mich.). June 26, 1959. 14p. Project No. 942. OTS.

The purification of 63% yttrium oxide feed was conducted by means of liquid-liquid extraction on the continuous 49-stage primary contactor and 21-stage acid back extractor. Yttrium oxide with purity of 97.5% to 99.0% was obtained in yields of 90% of the total yttrium oxide fed to the extractor system. The principal rare-earth impurities were ytterbium, cerium, and lanthanum. This investigation established the most operable conditions, including the concentration of the hydroxyethylethylenediaminetriacetic acid (HEDTA) and the sulfuric acid, the pH of the HEDTA, and

the flow rates for all the solutions employed in the liquid-liquid extraction system. The 49-stage pilot extractor was used to separate the yttrium and the heavy rare earths from the lights. The light rare earths were complexed with the aqueous HEDTA solution and the yttrium was extracted into the organic solution consisting of monododecylphosphoric acid, iso- or n-decanol, and kerosene. Yttrium ions were separated from the heavy rare-earth ions by the use of 0.2 normal sulfuric acid in the 21-stage acid back extractor. (auth)

4062 (TID-11096) THE REMOVAL OF LANTHANUM OXIDE FROM A YTTRIUM OXIDE CONCENTRATE BY MEANS OF LIQUID-LIQUID EXTRACTION. Report 256. Period covered: February 10, 1959 to April 6, 1959. L. D. McCowen (Michigan Chemical Corp., St. Louis, Mich.). June 29, 1959. 6p. Project 942. OTS.

The investigation of an aqueous scrub solution as an extracting agent for separating lanthanum from the Mallinckrodt rare-earth feed by liquid-liquid extraction has been successful with a sulfuric acid solution adjusted to a pH of 2.5. The lanthanum oxide was extracted with the aqueous acid solution, and the yttrium oxide and heavy rare earths were complexed into the organic solution consisting of monododecylphosphoric acid, iso-decanol, and kerosene. This report includes information obtained from the operation of an 8-stage and a 21-stage continuous countercurrent mixer-settler unit for the removal of lanthanum oxide from a yttrium oxide concentrate. Later this concentrate was fed to the continuous 49-stage primary contactor and 21-stage acid back extractor. The data reported show that in the 49-stage extractor, 99% of the total yttrium was upgraded from 68 to 91% before equilibrium was reached. (auth)

4063 (TID-11099) SEPARATION OF YTTRIUM FROM A RARE EARTH CONCENTRATE CONTAINING LARGE AMOUNTS OF IRON. Report 259. Period covered: February 26, 1959 to March 17, 1959. Patrick A. Lincoln (Michigan Chemical Corp., St. Louis, Mich.). July 7, 1959. 2p. Project 942. OTS.

A wet yttrium concentrate known as "green mud" was processed by partial dissolution in acetic acid. The resulting extract yielded 82% of the yttrium and only 2 to 3% of the iron present in the original feed. This extract would be suitable for further treatment by liquid-liquid extraction. (auth)

4064 (CEA-tr-I-36) EFFET DU TRAITEMENT À DIVERSES TEMPÉRATURES, APRÈS ABSORPTION, SUR LE POUVOIR SÉLECTIF DU PHOSPHATE DE ZIRCONIUM UTILISÉ EN TANT QU'ECHANGEUR INORGANIQUE. (Effect of Treatment at Different Temperatures, After Absorption, on the Selective Power of Zirconium Phosphate Used as an Inorganic Exchanger). G. Alberti and A. Conte. Translated into French by L. Roulet from Atti accad. nazl. Lincei, Rend. classe sci. fis. mat. e nat. (8) 26, 782-4 (1959). 8p.

A study was made of the effects treatment at various temperatures, after absorption of a mixture of ions, on the exchange selectivity of $Zr_3(PO_4)_4$. The study used strontium and cesium, and the heat treatments were performed at 25, 70, 100, 150, and 180°C for 2 hr, then the columns were eluted at 25°C with 2N HCl. The separation is ineffective at 77°C but becomes complete at 180°C. (T.R.H.)

4065 (CEA-tr-R-575) L'EXTRACTION EN TANT QUE MÉTHODE DE SÉPARATION ET D'ÉTUDE DES RADIOÉLÉMENTS. (Extraction as a Method of Separation and Study of Radioelements). V. M. Vdovenko. Translated into French from Zhur. Neorg. Khim. 3, 145-54(1958). 31p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 12, abstract No. 13837.

4066 (CEA-tr-R-874) EXTRACTION DU RUTHENIUM DES SOLUTIONS NITRIQUES FORTEMENT DILUÉES. (Extraction of Ruthenium from Very Dilute Nitric Acid Solutions). A. V. Nikolaev and N. M. Sinitsyn. Translated into French from Zhur. Neorg. Khim. 4, 1935-6 (1959). 6p.

Some extraction experiments were performed with ruthenium in HNO_3 using persulfate oxidizer in the presence of Ag^+. About 98% of the ruthenium could be separated. From neutral tracer solution, 98.5% of the radioruthenium was distilled. Increasing the HNO_3 concentration allowed separation of RuO_4. The ruthenium cannot be distilled in the form of a complex, $(NH_4)_2$ [Ru $NOCl_5$], because of $NaBrO_3$ and H_2SO_4, even when boiled and diluted. (T.R.H.)

4067 (CEA-tr-R-975) EXTRACTION DE CERTAINS ÉLÉMENTS DES TERRES RARES PAR LE TRIBUTYLPHOSPHATE. (Extraction of Certain Rare-Earth Elements by Tributyl Phosphate). V. Erzhabek (Arjabek) and A. K. Lavrukhina (Lavrouthina). Translated into French from Zhur. Neorg. Khim. 3, 1703-8(1958). 15p.

A better method for separation of rare earths in analysis of ores was needed, so an investigation was made of extraction by tributyl phosphate (TBP). Some extraction tests on 10 to 12N HNO_3 solutions containing Fe, Al, U, Ca, Mg, and La as carrier for the rare-earth tracers. The effect of TBP concentration is illustrated by a 15-fold increase in the distribution coefficient for neodymium when the TBP goes from 20 to 80%. The presence of uranium lowers the distribution coefficient. Yttrium is almost completely (95%) extracted by TBP. The degree of extraction increases with atomic number from cerium to erbium and goes up sharply with thulium. With previous uranium removal the degree of extraction remains practically constant from neodymium to thulium. A procedure is given for separating promethium and other elements from rare earths in the presence of other elements. (T.R.H.)

4068 (CEA-tr-R-1008) EXTRACTION DU CESIUM RADIOACTIF PAR UN MÉLANGE DE FERROCYANURES DE METAUX LOURDS. (Extraction of Radioactive Cesium by a Mixture of Heavy Metal Ferrocyanides). V. V. Pushkarev, L. D. Skrylev, and V. F. Bagretsov. Translated into French from Zhur. Priklad. Khim. 33, 81-5(1960). 13p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 19041.

4069 (CEA-tr-X-192) SÉPARATION DU STRONTIUM 90 ET DE L'YTTRIUM 90 À LA RÉSINE ÉCHANGEUSE ANIONIQUE DU TYPE OXALIQUE. (Separation of Strontium-90 and Yttrium-90 with Anion Exchange Resin of the Oxalic Type). S. Yajima. Translated into French from Bunseki Kagaku 7, 720(1958). 4p.

A 1% solution of Sr^{90} and Y^{90} in equilibrium was passed through a column of anion exchange resin of the oxalic type of which the pH was controlled between 2 and 7. The Sr^{90} passed through and the Y^{90} was absorbed. The Y^{90} is then eluted by 0.5N HCl. For a 0.5% NH_4Cl solution with Sr^{90}-Y^{90} at pH 6, the two are easily separated on oxalic-type anion exchange resin. (T.R.H.)

4070 (NP-tr-500) SOME RESULTS ON THE EXTRACTION PROPERTIES OF TRIBUTYLPHOSPHATE (TBP). S. M. Karpacheva, L. P. Khorkhorina, and A. M. Rozen. Translated by J. B. Sykes (U.K.A.E.A. Atomic

Energy Research Establishment) from Zhur. Neorg. Khim. 2, 1441-7(1957). 19p. (Includes original, 5p.). JCL or LC.

Results of investigations concerning the extraction properties of tributylphosphate in kerosene mixtures are presented. The effects of these mixtures on the distribution of uranyl nitrate and nitric acid are discussed. Extraction data are included. (J.R.D.)

4071 (NP-tr-517) THE EFFECT OF THE DILUENT ON THE EXTRACTION OF URANYL NITRATE BY TRIBUTYL PHOSPHATE. V. B. Shevchenko, A. S. Solovkin, I. V. Shilin, L. M. Kirillov, A. V. Rodionov, and V. V. Balandina. Translated by J. M. Crabtree (U.K.A.E.A. Atomic Energy Research Establishment) from Radiokhimiya 1, 257-69(1959). 24p. JCL or LC.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 5272.

4072 (UCRL-Trans-607(L)) EXTRACTION OF TRIVALENT AND PENTAVALENT ANTIMONY BY OXYGEN-CONTAINING SOLVENTS. D. I. Ryabchikov and M. M. Privalova. Translated from Zhur. Neorg. Khim. 3, 1694-1702(1958). 27p. (includes original, 9p.). JCL or LC.

The behavior of 10 oxygen-containing solvents in relation to trivalent and pentavalent antimony in hydrochloric acid solution with the aid of the radioactive isotope Sb^{124} was studied. n-Amyl, isoamyl, n-hexyl, and n-octyl alcohols are capable of a total extraction of Sb^{5+} from sufficiently concentrated hydrochloric acids solutions. Sb^{3+} is extracted by them only partially. An extraction maximum is observed on the Sb^{3+} distribution curve in the vicinity of the hydrochloric acid concentration of 5M. Esters (amyl acetate and benzyl acetate) extract Sb^{5+} well, and partially Sb^{3+}. Tributylphosphate totally extracts Sb^{5+} in the wide interval of the hydrochloric acid concentration (4 to 11M). Tributylphosphate also extracts Sb^{3+} well in the interval of the hydrochloric acid concentration of 1 to 7M and differs in this respect from all extractive reagents which have been studied and described in literature. Simple ethers, di-n-butyl and β, β'-dichlorodiethyl, at the concentration of hydrochloric acid >9M almost totally extract Sb^{5+}, and relatively small amount of Sb^{3+}. Diisoamyl ether totally extracts Sb^{5+} at the concentration of hydrochloric acid ≥11M. Sb^{3+} is not extracted by diisoamyl ether in the entire interval of the hydrochloric acid concentration which was studied (1 to 12M), and for this reason it can be used for separating trivalent and pentavalent antimony. In many cases the mechanism of extraction is not clear and needs additional study. (auth)

4073 SEPARATION AND DETERMINATION OF PLUTONIUM IN URANIUM–FISSION PRODUCT MIXTURES. William J. Maeck, Glenn L. Booman, Maxine Elliott Kussy, and James E. Rein (Phillips Petroleum Co., Idaho Falls, Idaho). Anal. Chem. 32, 1874-6(1960) Dec.

A two-cycle extraction procedure is described for the separation and determination of plutonium in uranium–fission product mixtures. Plutonium is oxidized to +6 with permanganate and quantitatively extracted as a tetraalkylammonium trinitrate complex into methyl isobutyl ketone from an acid-deficient aluminum nitrate salting solution. Plutonium is stripped from the organic phase and reduced to +3 with a hydroxylamine-iron(II) mixture, oxidized to +4 with nitrite, then quantitatively extracted into thenoyl-trifluoroacetone-xylene. Over-all fission product decontamination is greater than 1×10^4 and uranium carry-through is less than 0.05%. Over-all recovery of plutonium is 98.8%, dispensing with the need for a yield determination. (auth)

4074 TRIALKYL THIOPHOSPHATES. SELECTIVE EXTRACTANTS FOR SILVER AND MERCURY. T. H. Handley (Oak Ridge National Lab., Tenn.), and John A. Dean. Anal. Chem. 32, 1878-83(1960) Dec.

Triiso-octyl thiophosphate and tri-n-butyl thiophosphate, neutral esters of monothiophosphoric acid which contain an isolated P = S group, are highly selective extractants for silver and mercury(II) ions in nitric acid medium from the 35 elements tested. The extracted species are formed rapidly and the partition is easily reversed. From aqueous solutions 6M in nitric acid and for a 0.67M solution of the reagent in carbon tetrachloride, the partition coefficient at room temperature for silver exceeds 100; for mercury it is 90. The influence of a wide range of nitric acid, reagent, and silver concentrations, and the effects of temperature, diverse acids, and salting agents upon the partition equilibrium were investigated. Structures are postulated for the solvates formed between the reagent molecules and nitric acid and the metal nitrates. (auth)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

4075 (BAW-1194) GAS SUSPENSION TASK III—SUMMARY REPORT. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). June 15, 1960. Changed from OFFICIAL USE ONLY Oct. 18, 1960. 131p. Contract AT(30-1)-2316. OTS.

Heat-transfer data obtained with pure gas coolant agree well with the Dittus Boelter equation, thus attesting to the suitability of the equipment for heat-transfer investigations. The gas-suspension heat-transfer data were correlated by plotting Nu versus $Re_f(W_s/W_g)^{-0.6}$. Gas-suspension Moody friction factors appear to be of the same order of magnitude as those found for single-phase fluids. In terms of transported heat and pumping power, gas-suspension coolants are better than pure gas coolants. The greatest improvement is obtained by small additions of particulate matter to the carrier gas. The addition of particulate graphite to the working fluid of a gas turbine results in a higher cycle efficiency and an increase in the net work done per pound of gas circulated. To achieve these advantages a higher pressure ratio must be accepted and a higher regenerator efficiency provided. After a survey of gas-cooled reactors, the ORNL gas-cooled reactor, HTGR (Philadelphia Electric–Peach Bottom reactor), and the Maritime Gas Cooled Reactor were selected as the systems best able to demonstrate performance improvements through the use of a gas suspension. A preliminary test of a screw type pump indicated considerable over-all promise and also the need for better seals. The Soxlet organic-residue extraction procedure was studied and an optimum reflux time of 6 hr established. Off-gas studies are now done by pumping gas directly from the furnace to a mass spectrometer. Techniques needed for the Fission Product Distribution Study have been developed and Kr^{85}, Br^{82}, and Rb^{86} have been selected for study. The design of the in-pile loop addition and a hazards analysis for the suspension reactor irradiation study are complete. Apparatus for the graphite lubrication study was designed and all parts were ordered. (auth)

4076 (BAW-1201) GAS-SUSPENSION—TASK III. Final Report. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). July 31, 1960. Changed from OFFICIAL USE ONLY Oct. 18, 1960. 254p. Contract AT(30-1)-2316. OTS.

The work in Task III has provided heat transfer and pressure drop correlations for gas suspensions and supplied preliminary information on fission-product retention, lubrication characteristics, offgassing properties, and irradiation effects. In addition, coolant comparison and component sizing studies were made to illustrate the potentialities of this coolant for reducing pumping power, pump size, and cost of the reactor and other components of gas-cooled nuclear power plants. Most of the fission-product-retention study results and additional heat-transfer and pressure-drop data will be submitted later in a report describing the results obtained during a 30-day extension to complete this work. The development of gas-suspension technology through Tasks I, II, and III of this contract has continued to demonstrate with increasing clarity the advantages of these fluids as reactor coolants. (auth)

4077 (HW-62049) ACCURACY OF VOLUME MEASUREMENTS IN A LARGE PROCESS VESSEL. C. L. Pleasance. General Electric Co. Hanford Atomic Products Operation, Richland, Wash. Oct. 19, 1959. 14p. Contract AT(45-1)-1350. OTS.

A study was conducted on the accuracy of volume measurements of solutions in large vessels by precision manometers under plant processing conditions. (C.J.G.)

4078 (NAA-SR-4336) PERFORMANCE OF HNPF PROTOTYPE FREE-SURFACE SODIUM PUMP. R. W. Atz. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. June 30, 1960. 26p. Contract AT-11-1-GEN-8. OTS.

A free-surface centrifugal pump, incorporating a hydraulic bearing running in sodium, was operated at the conditions required for service in the Hallam Power Reactor. After difficulties arising from inadequate shaft clearances were alleviated, the pump performed properly at a flow rate of 7200 gpm of 945°F sodium at 150-ft head. Results indicate that this pump should perform satisfactorily in the Hallam plant. (auth)

4079 (NAA-SR-4387) TESTING OF HNPF FREEZE-SEAL PUMP. R. W. Atz. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Nov. 1, 1960. 48p. Contract AT-11-1-GEN-8. OTS.

A centrifugal pump performed adequately at a flow rate of 7200 gpm of 945°F sodium at a 150-ft head. A two-region freeze seal was developed and used successfully as a shaft seal on this pump. The results indicate that this pump could perform satisfactorily in the Hallam Power Reactor. (auth)

4080 (NAA-SR-Memo-2184) LIQUID METAL SEAL FOR SODIUM PUMP SHAFTS. S. C. Carniglia. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Oct. 4, 1957. 7p. OTS.

Several liquid metal sealants were investigated for sodium-pump shafts. (W.L.H.)

4081 (NAA-SR-Memo-2616) A GAS SHAFT SEAL FOR THE HNPF SODIUM PUMP. B. W. Admire and F. S. Nayor (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 30, 1958. 6p, OTS.

Lip type, oil labyrinth gas shaft seals were tested for use on Hallam Power Reactor sodium pumps with a 5-in.-diameter rotating shaft. The seals were not recommended for use owing to excess helium leakage and short life. (C.J.G.)

4082 (NAA-SR-Memo-4411(Rev.)) A DESCRIPTION OF SGR TEST INSTALLATIONS AVAILABLE AT ATOMICS INTERNATIONAL. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 15, 1960. 51p. Contract AT-11-1-GEN-8. OTS.

Illustrations and descriptions of component test loops and sodium laboratories available at the Nuclear Field Test Laboratory of Atomics International are presented. (C.J.G.)

4083 (NAA-SR-Memo-4742) THEORETICAL ANALYSIS OF THE HELICAL ROTOR ELECTROMAGNETIC PUMP. R. S. Baker (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 3, 1960. 78p. OTS.

An equation is derived that relates the magnetic flux density and the resultant pressure in the helical rotor electromagnetic pump. Rudenberg's derivation of the equation for braking force in an eddy-current brake is presented. Based on the work of Rudenberg, equations are derived for the pressure developed by the pump. The method employed consists of calculating the eddy-current power loss in a given volume of a liquid metal conductor that is exposed to a traveling magnetic field, then to calculate the pressure by dividing the power loss by the velocity of the field relative to the liquid metal. (C.J.G.)

4084 (NAA-SR-Memo-5004) NaK PUMP EVALUATION. R. S. Baker and W. J. Fraser. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Feb. 18, 1960. 30p. OTS.

Four types of electromagnetic pumps were considered, from an efficiency and weight standpoint, for the task of pumping 11 gpm of 78%K NaK having a temperature of 1000°F with a pressure rise across the pump of 4 psi. The d-c conduction electromagnetic pump appeared to be the most suitable. Characteristics of all four types are listed. (W.D.M.)

4085 (NAA-SR-Memo-5433) WOUND-ROTOR ELECTROMAGNETIC PUMP FOR NaK. R. S. Baker and W. J. Fraser. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. June 22, 1960. 15p. OTS.

Design sheets were prepared for an electromagnetic wound-rotor pump developing 4 psi at 13 gpm pumping 1000°F NaK. Computations showed an efficiency of 2.8% and a weight of 71 lb. The design sheets describe the method of designing this type of pump and calculation of pump performance. (W.D.M.)

4086 (NP-9486) GAS-LUBRICATED CYLINDRICAL JOURNAL BEARINGS OF FINITE LENGTH. PART II. DYNAMIC LOADING. B. Sternlicht (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Sept. 9, 1960. 45p. Contract NONR 2844 (00).

Numerical solutions of the quasi-steady state Reynolds equation are presented for finite-length gas-lubricated cylindrical journal bearings under dynamic loading (in which the journal center rotates and translates). Employing stationary and rotating coordinate systems, correspondence relations are established for the derivatives of force with respect to displacement and velocity using first-order perturbation solutions. Comparison of the iterative

and first-order perturbation solutions is made. The results are presented in dimensionless form. (auth)

4087 (TID-4100(1st Rev., Suppl.9)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Richard E. C. Duthie, ed. (Office of Technical Information Extension, AEC). Sept. 1960. 70p.

Lists of engineering materials including hot laboratory equipment and structure, metallurgical equipment and processes, nuclear radiation instruments, nuclear reactors and facilities, particle accelerators, plant designs and processes (chemicals), radiation source units, shielded containers, and thermonuclear devices are presented. (J.R.D.)

4088 DEFINITION OF THE CHIEF PHYSICAL QUANTITIES IN USE IN VACUUM TECHNIQUES, AND THEIR CORRESPONDING UNITS. J. C. Boulassier (Centre d'Etudes Nucléaires, Saclay, France). Vide No. 79, 29-35(1959) Jan.-Feb. (In French) (CEA-1284)

Vacuum technicians desire to adopt the coherent systems of units generally used in physics. An internal standardization project in the CEA is presented, and a brief review is given of the definitions of the physical quantities to which it applies. (auth)

4089 EXPERIENCE ON ULTRA-HIGH VACUUM IN THE DEVICES USED FOR RESEARCH ON CONTROLLED FUSION. Z. Sledziewski and A. Torossian (Centre d'Etudes Nucléaires, Saclay, France). Vide No. 81, 107-12(1959) May-June. (In French) (CEA-1376)

The pumping system of TA 2000 is presented. TA 2000 is a metal torus for high intensity discharge studies, the volume of which is about 400 liters. The assembly is made with metal gaskets, a total of 168. Pumping is achieved with classical oil diffusion pumps with double liquid-nitrogen traps and all metal valves 100 mm in diameter. Pressures as low as 3×10^{-9} mm of mercury at pumping exit and 3×10^{-8} in the most remote part were measured with Alpert type ionization gages. (auth)

Heat Transfer and Fluid Flow

4090 (AERE-M-633) THE DRAG ON A $\frac{1}{2}$" SPHERE IN WATER AT Re = 25 TO 100. G. A. Henwood and P. N. Rowe (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Feb. 1960. Reprinted Sept. 1960. 18p. BIS.

Drag forces of the order of 10^{-4} gram weight were measured on small spheres in water as part of a study of fluidization. The results do not agree with previously published values but are consistently higher. Because of general interest in fundamental data of this kind, the results are reported in detail together with a full description of the experimental method. (auth)

4091 (AFOSR-TN-60-291) HALL EFFECTS IN A LAMINAR BOUNDARY LAYER OF THE HARTMANN TYPE. Research Report No. 81. James A. Fay. Dec. 1959. Avco Corp. Avco-Everett Research Lab., Everett, Mass. 11p. Contract AF49(638)-659. (AD-236654).

The motion in a laminar boundary layer on an infinite flat plate with an applied magnetic field normal to the wall and current flow parallel to the wall is studied for the case of $\omega\tau$ (electrical cyclotron frequency times mean free time) not necessarily small. It is found that a cross flow is induced normal to both magnetic field and free stream flow. The net electrical power loss in the boundary layer is determined assuming constant transport properties. (auth)

4092 (CF-60-9-116) THERMAL CHARACTERISTICS OF FLUID FLOW IN PIPES. D. B. Hinton (Oak Ridge National Lab., Tenn.). Sept. 13, 1960. 22p. OTS.

Studies were made to determine the adequacy of presently used analog circuits in solving dynamic fluid-flow heat-transfer equations. A mathematical analysis is made of dynamic heat transfer in pipes with zero losses, with losses proportional to pipe temperature, and with heat inputs. The results of this analysis are compared with the analog results by means of generalized temperature vs. time graphs. The analog circuit is found to be adequate for most conditions, but sometimes requires modification when heat inputs are considered. (auth)

4093 (DP-512) IBM 659 ROUTINE VI TEMPERATURE DISTRIBUTION IN FUEL ELEMENTS. James C. Jensen. Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C. Sept. 1960. 48p. Contract AT(07-2)-1. OTS.

Equations and a routine for the IBM 650 to calculate temperatures within cylindrical fuel assemblies are presented. The routine can accommodate as many as three coaxial fuel tubes and four coolant channels. (auth)

4094 (NAA-SR-Memo-2277) FRICTIONAL PRESSURE DROP OF SANTOWAX R IN STRAIGHT PIPE. D. I. Gilbert (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 19, 1957. 24p. OTS.

An estimate of frictional pressure drop in clean steel and wrought iron pipe was made. The effects of temperature, high-boiler polymer, mass rate of flow, and pipe size were determined. Standard pipe dimensions are used throughout except for 22-in. pipe where there is no standard. The maximum calculated pressure loss which occurs over the temperature range 300 to 700°F and 0 to 30% polymer is shown. (W.L.H.)

4095 (NDA-2131-16) COMPILATION OF EXPERIMENTAL FORCED-CONVECTION, QUALITY BURNOUT DATA WITH CALCULATED REYNOLDS NUMBERS. H. Firstenberg, K. Goldmann, L. LoBianco, S. Preiser, and G. Rabinowitz. Nuclear Development Corp. of America, White Plains, N. Y. June 30, 1960. 60p. Contract AT(30-1)-2303(IX). OTS.

The basic data and calculations are presented in two tables. Table 1 contains the experimental quality burnout data, and Table 2 contains the calculations of Reynolds numbers and enthalpy at the points of burnout. Table 3 provides an index and gives the sources of the data. (auth)

4096 (NP-9322) AN EXPERIMENTAL INVESTIGATION OF LIQUID DISTRIBUTION AND SURFACE CHARACTER IN HORIZONTAL ANNULAR TWO-PHASE FLOW. Interim Report No. 1. H. N. McManus, Jr. (Cornell Univ., Ithaca, N. Y. Sibley School of Mechanical Engineering). Oct. 1959. 58p. OOR Project No. 2117. Contract DA-30-115-ORD-992.

A series of tests was made to measure mean and minimum film thickness, wave height, and pressure drop in horizontal tubes under gas and liquid two-phase flow. Three pipe sizes were employed, 1-, 2-, and 3-in. inside diameter, and the film profiles measured at several axial positions. The Reynolds number varied from 59,000 to 316,000 for gases and from 77 to 10,000 for liquids. Two fluids, water and a water-glycerine solution, differing in

viscosity by a factor of ten, were employed. The mean thickness data were correlated. The Reynolds number for a liquid was found to be a controlling factor in the correlation. Wave height was found to be correlated by mean film thickness. (auth)

4097 (NP-9337) INSTRUMENTATION FOR MAGNETOAERODYNAMIC HEAT TRANSFER. Richard W. Ziemer (Space Technology Labs., Inc. Physical Research Lab., Los Angeles). Sept. 8, 1960. 40p. Contract AF04(647)-309. (STL/TR-60-0000-09290).

A technique is described for directly measuring the stagnation point heat-transfer rate to an aerodynamic model in an electromagnetic shock tube. The surface temperature of a model exposed to aerodynamic heating was measured by means of quantitatively detecting the thermal radiation from a surface film. The major problem in utilizing the instrument for heat-transfer measurements is the damage to the sensing film by high speed flow. (C.J.G.)

4098 (SCTM-183-60(51)) PLASMA-JET ELECTRODE HEAT TRANSFER STUDY. D. A. Byrne (Sandia Corp., Albuquerque, N. Mex.). July 1960. 17p. OTS.

A study of the heat-transfer problems encountered in the design of a plasma-jet head is undertaken. Methods are outlined for computing the maximum heat flux through the electrodes to the coolant. The methods show how the heat flux may be maximized by varying electrode geometrics. (auth)

4099 (VDIT-17) SPRAY-KYLNING. EN SELEKTIV BIBLIOGRAFI. (Spray Cooling. A Bibliography of Selected Literature). Ernst Bock (Aktiebolaget Atomenergi, Stockholm). 1960. 24p.

A bibliography containing 96 references is presented on various aspects of spray cooling. (C.J.G.)

4100 (CNTr-8) FLUSSI TERMICI CRITICI (DI BURN-OUT) PER L'ACQUA CORRENTE NEI TUBI. (Critical Burnout Heat-Flux for Flowing Water in Pipes). I. T. Alad'ev, L. D. Dodonov, and V. S. Udalov. Translated into Italian from Atomnaya Energ. 6, 74-8(1959). 13p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 18462.

Instrumentation

4101 (AERE-M-714) A PROPOSED METHOD OF REDUCING THE DETECTOR INELASTIC BACKGROUND IN PROTON REACTION CROSS-SECTION MEASUREMENTS. P. E. Cavanagh (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). June 1960. 9p.

A technique for reducing the detector inelastic background in proton reaction cross-section measurements, using the Eisberg-Gooding method, is described. The technique consists of using a dE/dx and a total-energy scintillator in coincidence as a composite detector following the target. (C.J.G.)

4102 (AFOSR-TN-60-1235) CONVERSION OF DIFFRACTOMETERS FOR SMALL ANGLE SCATTERING. Robert H. Bragg and L. E. Copeland. Illinois Inst. of Tech., Chicago. Armour Research Foundation and Portland Cement Assn., Skokie, Ill. Oct. 1, 1960. 30p. Contract AF49(638)-829.

A simple, rapid conversion of a diffractometer from conventional diffractometry to small-angle scattering is described. The conversion consists of adding an attachment that provides a much larger separation than is usual between the slits limiting the angular divergence of the beam scattered by the sample that reaches the detector. Usable measurements can be made down to 0.10° 2 θ. The attachment is inexpensive to construct and can be installed and aligned in about 30 min. Sample preparation requires only a few minutes and both solids and liquids are handled with equal facility. Intensity data are obtained by means of manual fixed count measurements and a complete pattern for most materials can be obtained in about one hour. The range of intensity encountered in materials, e.g., Magnesite, colloidal graphite, silica gel, and silica sols can be as great as 10^4 : 1. This makes possible comparison of the experimental curves with theory for both small and large values of the scattering vector. (auth)

4103 (BAW-1069) LIQUID METAL FUEL REACTOR EXPERIMENT. NONNUCLEAR INSTRUMENTATION FOR LIQUID BISMUTH SERVICE. B. L. Birch. Babcock and Wilcox Co. Research Center, Alliance, Ohio. Apr. 1960. Changed from OFFICIAL USE ONLY Oct. 18, 1960. 61p. Contract AT(30-1)-1940. OTS.

A series of tests on nonnuclear instrumentation for liquid-bismuth use was designed to simulate the Liquid Metal Fuel Reactor (LMFR) environment insofar as possible and to evaluate these instruments for liquid-bismuth service. The instruments tested were thermocouples, pressure-sensing instruments, liquid-level indicators, and flowmeters; pressure-sensing diaphragms and thermocouple compression fittings were also tested. All tests consisted of preliminary calibrations and response-rate tests, testing in a dynamic bismuth loop, and then another calibration and response-rate test. (auth)

4104 (CREL-943) A SOLID-STATE TAPE-TO-TYPE TRANSLATOR. J. Leng and R. E. Archinuk (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). June 1960. Includes "CIRCUIT DESCRIPTION OF SOLENOID DRIVER, UNIT EB-111," by L. B. Robinson. 51p. (AECL-1091). AECL.

This system was designed to read punched paper tape and produce a typewritten record. In addition it checks for parity failures and false codes. All the logic of the system is carried out using transistor circuitry, which is discussed in detail. The only electromechanical devices are a motorized tape-reader and an electric typewriter. (auth)

4105 (HW-66088) A FINGER RING IONIZATION CHAMBER FOR THE MEASUREMENT OF PRODUCTION PLUTONIUM HAND DOSES. Leo G. Faust (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 22, 1960. 13p. Contract AT(45-1)-1350. OTS.

An ionization chamber in the form of a ring was designed and is now in the final stages of development. The chamber's primary function is to measure the hand dose received from production plutonium. It could also be used wherever a γ-emitting isotope is present. To correctly interpret the dose, measured by the ring from a mixed-energy field, such as found in production plutonium, weighing factors were developed from experimentally determined values. The dose from production plutonium is then related to a γ calibration by these factors. Radium γ doses of 500 mr were measured with an error of not more than +6%. (W.L.H.)

4106 (HW-67371) CHARACTERISTICS OF XENON FILLED ION CHAMBERS. R. E. Connally (General Elec-

tric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 12, 1960. 6p. Contract AT(45-1)-1350. OTS.

A xenon-filled ion chamber was evaluated for use with existing and future absorptiometers using Am^{241} or Tl^{170} gamma sources. A comparison of xenon to air as the filling gas was made. The increased response with xenon resulted in a steadier current, and the cesium to americium ratio of 10 decreased the absorptiometer error due to fission-product content in the stream or sample under analysis. (C.J.G.)

4107 (NAA-SR-Memo-3328) DRIVER AND DETECTOR CIRCUIT FOR PRECISION SODIUM LEVEL PROBE. J. R. Campbell. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Jan. 13, 1959. 9p. OTS.

A driver and detector circuit was designed which provides a satisfactory indication of the sodium level in a vessel as a dip-stick probe traverses the sodium surface. (C.J.G.)

4108 (NAA-SR-Memo-5188) DESIGN OF THERMAL CONDUCTIVITY APPARATUS. D. M. Lonneaux (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 22, 1960. 24p. OTS.

An apparatus was designed for determining the thermal conductivity of UC and other materials. The apparatus is of the guarded cylinder type with the heat induced to flow axially through a cylindrical test bar of UC. One end of the bar is heated by a resistance heater, while a constant-flow water calorimeter at the other end measures the heat flux. Radiation heat transfer is controlled by radial and axial heat guards built around the UC test bar. (C.J.G.)

4109 (NP-9356) MEDICIÓN DE FLUJO DE NEUTRONES RÁPIDOS POR MEDIO DE DETECTORES UMBRAL. INFORME NO. 9. (Measurement of Fast Neutron Flux by Means of Threshold Detectors. Report No. 9). Delfina Ricabarra, Rosa Turjanski, and A. H. W. Aten, Jr. Argentina. Comision Nacional de Energía Atómica, Buenos Aires. Nov. 1959. 8p.

The Si^{31} activity induced in phosphorus is very convenient for measurement of fast neutrons (E > 2 Mev) in a reactor. The results are equivalent to those obtained by measuring the P^{32} in sulfur samples. (tr-auth)

4110 (R57SD418) THERMAL CONDUCTIVITY AND ITS MEASUREMENT OF HIGH TEMPERATURE MATERIALS. W. H. Sutton. General Electric Co. Aerosciences Lab., Philadelphia. Aug. 1957. 19p.

Results of a literature survey concerning methods used to determine the thermal conductivity of high-temperature materials are presented. Several factors which limit the reliability and accuracy of measurement are considered. Over 30 types of apparatus are discussed and compared according to the accuracy, temperature range, time required for measurement, sample size or shape, and methods used. (auth)

4111 (SCR-227) FLUSH PRINTED CIRCUIT BOARDS FOR TIMING SWITCHES FOR MILITARY APPLICATIONS. R. E. Whitford (Sandia Corp., Albuquerque, N. Mex.). Oct. 1960. 18p. OTS.

Design requirements for flush-printed circuit boards for timing switches for military applications are presented. Processes and materials for the production of printed circuit boards that will meet the necessary requirements for these applications are described. (C.J.G.)

4112 (SCTM-142A-57(52)) A SURVEY OF FAST-RISING BALLOONS AND RAWIN REFLECTORS. T. J. Raftery and H. J. Plagge. Sandia Corp., Albuquerque, N. Mex. Oct. 21, 1960. 9p. OTS.

A study was made of the capabilities of the fast-rising balloons and radar reflectors which are currently available for meteorological purposes. The reason for this study was to determine which are best suited for Sandia Corporation requirements. (auth)

4113 (SCTM-277-60(27)) ADDING A SEVENTH DIAL TO THE LEEDS & NORTHRUP G-2 MUELLER BRIDGE. J. L. Hartley. Sandia Corp., Albuquerque, N. Mex. Aug. 17, 1960. 11p. OTS.

A method of adding a seventh dial to the G-2 Mueller bridge without changing its original circuit is described. When using a 25-ohm platinum resistance thermometer, the dial extends the temperature resolution of the bridge from 0.001 to 0.0001°C. By the use of the added dial, the zero correction for the bridge can be determined with a resolution of 0.00001 ohm. Greater resolution also is obtained in adjusting the bridge ratio arms. (auth)

4114 (SCTM-304-60(14)) ELECTRICAL FUSES AND THEIR UTILIZATION IN SANDIA CORPORATION SYSTEMS. C. D. Longeret. Sandia Corp., Albuquerque, N. Mex. Nov. 1960. 22p. OTS.

The electrical fuses in general and the way in which they are applied in Sandia Corporation systems are described. Fuseology, design influences, applications, and testing are discussed. (auth)

4115 (TID-6825) A SMALL FOCAL-SPOT X-RAY GENERATOR USING BETA-RAYS. Quarterly Progress Report No. 5 Covering the Period June 1, 1960–September 1, 1960. Research Report 60R20. Jacob Kastner, Mike Moe, R. J. Lambert, and J. Parks. Picker X-Ray Corp. Picker Research Center, Cleveland. 20p. Project No. EXR-514. Contract AT(11-1)-746. OTS.

Permanent ceramic wafer magnets were successfully employed as substitutes for electromagnetic quadrupole lens systems to focus β rays and to form an inefficient but practicable x-ray generator. The question of ultimate efficiency of β-ray collection by a magnetostatic focusing system was studied thoroughly. Because of a recognition of the limitations of this system, experimental emphasis is being shifted to dynamic focusing systems. (auth)

4116 (WADC-TR-59-728) TASK PERFORMANCE WITH THE CRL MODEL 8 MASTER-SLAVE MANIPULATOR AS A FUNCTION OF COLOR-CODING, DISTANCE, AND PRACTICE. D. Frederick Baker and Billy M. Crawford. Wright Air Development Center. Aerospace Medical Lab., Wright-Patterson AFB, Ohio. Nov. 1959. 19p. Project No. 7184.

The ability of Master-Slave Manipulator (CRL Model 8) operators to identify the slave hands and their movements with corresponding components and functions of the human body was investigated. A handling task involving rearrangement of blocks was devised to be performed with standard slave jaws (red jaws) and with slave jaws modified so that the jaw corresponding to the thumb of the operator was green. The task was performed at distances of 9, 36, and 63 in. from the radiation shield. Work time as a function of task distance was investigated and work ratios, based on mean time scores for direct handling vs. remote handling, were determined. (auth)

4117 (WADD-TR-60-293) A PROTON-RECOIL ORGANIC SCINTILLATION SPECTROMETER AND INVESTI-

GATION INTO A VARIABLE THRESHOLD SPARK COUNTER. [Period covered] February 18, 1959–May 17, 1960. John B. Ashe, William E. Tucker, O. M. Hudson, Jr., and J. T. Prud'homme. Texas Nuclear Corp., Austin, Tex. May 17, 1960. 34p. Project No. 7360. Contract AF33 (616)-6362. OTS.

Research that was conducted on two possible neutron spectral measuring devices based on the detection of recoil protons is described. A scintillation detector is described that has the ability to differentiate between neutrons and γ rays by means of the different decay times of recoil proton and Compton electron scintillations. This detector has been incorporated into a neutron spectrometer that is highly insensitive to γ rays over a detectable neutron energy region of approximately 0.8 to greater than 17 Mev. Data obtained with the spectrometer are presented. In addition to the scintillation detector, investigations into the feasibility of using a spark counter as an energy-sensitive neutron detector are also described. The results of these investigations are discussed and representative data are presented. (auth)

4118 (CEA-tr-R-876) CIRCUIT DE COINCIDENCES À FAIBLE TEMPS DE RÉSOLUTION. (Coincidence Circuits with Low Resolving Times). A. A. Rudenko. Translated into French from Pribory i Tekh. Eksp. No. 6, 60-2 (1958). 8p.

A simple coincidence circuit is described with a millimicrosecond resolving time. It is useful in physics experiments involving particle counting. The circuit does not require amplitude equalization and might be of use for detection of particles of an extended energy spectrum. (tr-auth)

4119 DETERMINATION OF TETRAMETHYLLEAD AND TETRAETHYLLEAD IN GASOLINE BY MASS SPECTROMETRY. H. E. Howard, W. C. Ferguson, and L. R. Snyder (Union Oil Co. of California, Brea). Anal. Chem. 32, 1814-15(1960) Dec.

Standard procedures in the oil industry for determining tetraethyllead additive in gasoline are based on determination of the lead and calculation of a tetraethyllead concentration from the lead value. These procedures cannot be used when both tetraethyl- and tetramethyllead fluids are used as additives and where a knowledge of the concentration of either or both of them is required. An accurate mass spectrometric procedure has been developed which permits the rapid analysis of gasoline for tetramethyllead and/or tetraethyllead. (auth)

4120 AN IMPROVED ALPHA-COUNTING TECHNIQUE. Naomi A. Hallden and John H. Harley (U. S. Atomic Energy Commission, Health and Safety Lab., New York). Anal. Chem. 32, 1861-3(1960) Dec.

A scintillation technique for α counting with a zinc sulfide phosphor is described which exhibits higher efficiency and lower background than the standard techniques. The zinc sulfide is coated on a Mylar base, and disks of the phosphor are applied directly to the sample. Counter efficiencies of about 47% are attained and the background is less than 1 count/hr. (auth)

4121 4-PI ZINC SULFIDE ALPHA COUNTING. N. Irving Sax and David Rosi (New York State Dept. of Health, Albany). Anal. Chem. 32, 1900-1(1960) Dec.

Two methods of sample preparation are described for 4π alpha counting with a scintillation detector containing plastic-dispersed ZnS film. (1) Plastic films of area 40 cm^2 can hold up to 50 mg carrier weight with very little decrease in instrument efficiency and are prepared by transferring the barium radium sulfates precipitate with 95% EtOH to the ZnS-impregnated film and drying under an infrared lamp. Adjustment of the spectrometer enables measurements of 10^{-14} g radium per sample to be made. (2) Silver-activated ZnS is mixed with the barium radium sulfates as a slurry in 95% EtOH, transferred to a counting vial, and allowed to dry. The use of a vial prevents contamination of either the sample or the surroundings. (D.L.C.)

4122 LATENT-IMAGE FADING IN FILM BADGE DOSIMETERS. C. A. Ziegler and D. J. Chleck (Tracerlab, Inc., Waltham, Mass.). Health Phys. 4, 32-4(1960) Oct.

The primary purpose of this study was to establish the feasibility of using a cumulative film as well as a weekly film in film badge dosimeters, since use of a 3 month cumulative film would allow about a tenfold reduction in minimum reported dose over that obtainable with weekly film. The parameter of most interest is the film latent-image fading period. This was investigated for times up to 90 days under varying environmental conditions. The controlling factor was found to be humidity. Use of a film wrapper impervious to water vapor should effectively solve the problem. (auth)

4123 A COMPENSATED IONIZATION CHAMBER FOR THE MEASUREMENT OF THE THERMAL NEUTRON FLUX. J. Kalus and M. Pollermann (Technische Hochschule, Munich). Kerntechnik 2, 319-22(1960) Oct. (In German)

An ionization chamber compensated for γ radiation was developed with which the thermal neutron flux or the output of a reactor can be measured over 7 decades. In this range the current intensity is linearly dependent on the output. The sensitivity for neutrons is $S_n = 7.8 \times 10^{-15}$ amp/sec/cm^2. The maximum flux is 10^{11} neutrons sec^{-1} cm^{-2}. The compensation was mechanically produced. (tr-auth)

4124 SIMPLE ANTICOINCIDENCE ARRANGEMENT WITH TWO PROPORTIONAL FLOW-THROUGH COUNTERS FOR THE DETERMINATION OF SMALL BETA ACTIVITIES. H. Fessler, H. Kiefer, and R. Maushart (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik 2, 324-6(1960) Oct. (In German)

Two anticoincidence arrangements used for the measurement of low β activities were described. The arrangements used gas flow-through counters with latticed arranged counter wires both as shielded counter and measuring counter. In the first device the preparation is brought between two counters each with 300 cm^2 of effective counting surface and can be measured either in 2 or 4π geometry. In the second device the preparation is placed between a similar shielded counter but a somewhat smaller measuring counter. Its electrode lattice can be interchanged easily so that counting surfaces of various sizes up to 69 cm^2 are possible. From measurements with electrodes of various diameters it is shown that the specific zero effect in each case is 0.1 pulse/min cm^2 of counter surface or less in a lead shield of only 100 kg. The optimum electrode sizes for test preparations of various diameters were discussed. (tr-auth)

4125 PORTABLE MONITOR FOR FAST NEUTRONS. E. Leiter (AEG-Studiengruppe EL/M, Munich). Kerntechnik 2, 327-9(1960) Oct. (In German)

A portable radiation detection device which permits the detection of fast neutrons from 0.1 to 15 Mev and the determination of the dose rate accurately to less than 20%

was described. The four linear measurement ranges are calibrated in pulses/sec (0 to 5, 0 to 25, 0 to 50, and 0 to 500). The tolerance dose rate corresponds to 3.6 pulses/sec. The instrument has the dimensions of 310 by 130 by 150 mm, weighs 5500 g, and is completely transistorized. The operation, construction, and properties are described. The instrument was tested at the Munich Research Reactor, and the results were good. (tr-auth)

4126 PRODUCTION OF A UNIFORM MAGNETIC FIELD BY MEANS OF AN END-CORRECTED SOLENOID. M. E. Gardner, J. A. Jungerman, P. G. Lichtenstein, and C. G. Patten (Univ. of California, Davis). Rev. Sci. Instr. 31, 929-34(1960) Sept.

Calculations and experimental technique used in producing a uniform magnetic field with an end-corrected solenoid are discussed. The field was trimmed to be uniform to 0.01% in an axial region comprising 63% of the solenoid at a maximum field strength of 480 gauss. (auth)

4127 RECORDING rf SPECTROMETER FOR NUCLEAR QUADRUPOLE ZEEMAN SPECTRA. C. Dean (Univ. of Pittsburgh). Rev. Sci. Instr. 31, 934-41(1960) Sept.

A semiautomatic recording spectrometer system finds the loci of magnetic-field orientations, relative to a single crystal sample, for which an unsplit component occurs in the Zeeman spectrum of chlorine nuclear quadrupole resonances from the sample. The system operates continuously without attention, except for approximately daily resetting, for up to several weeks to obtain the data for crystals with weak spectra. Circuit diagrams are given for the system components, and the analysis of the data is discussed. (auth)

4128 MULTIPLE COINCIDENCE CIRCUIT. Robert L. Chase (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr. 31, 945-9(1960) Sept. (BNL-4827).

A general purpose "fast-slow" multiple coincidence circuit is described. Three independent sets of fast coincidence conditions and three independent sets of slow coincidence conditions, involving up to five input signals, can be imposed simultaneously using a plug board and a set of patch cords. Coincidence pulse timing is accomplished with the aid of a unique discriminator circuit which can be used to detect either an early point on the rise of the input signals or the time of input signal zero transition. The discriminator bias can be varied over a wide range without affecting the circuit recovery time. The "fast" coincidence resolving time can be adjusted from 0 to 0.18 μsec, and signal delays can be adjusted over a 0.3-μsec range. The "slow" coincidence resolving time is fixed at approximately 2 μsec. Semiconductor active elements are used exclusively. (auth)

4129 APPLICATION OF ANALOG COMPUTERS TO ESR SPECTROSCOPY. M. L. Randolph (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr. 31, 949-52(1960) Sept.

By coupling an analog computer to a conventional high-sensitivity electron spin resonance (ESR) spectrometer, the total absorption of ESR spectra, which is essentially proportional to the total number of resonances present, is obtained automatically with a typical standard error of 8% for uncorrected data or 2% for simply corrected data. Other considerations inherent in the combination of such equipment are also discussed. An experimental check of the linear dependence of first moment of the usual spectrometer output on field modulation is given. (auth)

4130 SIMPLE TECHNIQUE FOR THE AUTOMATIC RECORDING OF MONOLAYER COMPRESSION CHARACTERISTICS. J. Adin Mann, Jr. and Robert S. Hansen (Ames Lab., Ames, Iowa). Rev. Sci. Instr. 31, 961-3(1960) Sept. (IS-59).

Trurnit and Lauer [Rev. Sci. Instr. 30, 975(1959)] recently described an automatic-recording film balance system suitable for automatic recording of many properties of insoluble surface films. Work was done on an instrument similar in principle, somewhat less versatile, but very simply constructed by modifying a Cenco hydrophil balance. It is well-suited for automatic recording of force-area curves for monolayers spread on aqueous substrates. Major components include a linear differential transformer, lead screw barrier advance system, and an x-y recorder. The practicality of the apparatus was demonstrated on a stearic acid monolayer spread from benzene on a distilled water substrate. Sensitivity of 0.01-dynes/cm in spreading pressure and 0.1 A^2 in molecular co-area was readily obtained, together with a surface pressure range of 0 to 60 dynes/cm. (auth)

4131 DISPLACEMENT-TYPE He II HEAT SWITCH. Ferdinand J. Shore (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr. 31, 966-9(1960) Sept. (BNL-4843).

The operation is described of a heat switch in which the conducting substance is liquid He II. The nonconducting state is achieved by displacing the He II with a poor conductor, e.g., Teflon. The switch is well-suited for use in the first stage of a magnetic refrigerator operating with a bath temperature near 1°K. At this temperature it performs better than a lead superconducting switch. (auth)

4132 USE OF GRAPHITE AS LOW TEMPERATURE SUPPORT AND SHUNT FOR HEAT SWITCH. F. J. Shore, V. L. Sailor, H. Marshak, and C. A. Reynolds (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Inst. 31, 970-3 (1960) Sept. (BNL-4821).

Artificial pitch-bonded graphite is known to exhibit an extremely large variation of heat conductivity with temperature. It is both rigid and strong, and below 1°K its heat conductivity is exceptionally small. For these reasons it is an ideal support material for use within the adiabatic enclosure of a cryostat operated below 1°K. Furthermore, above liquid-nitrogen temperature, graphite is an excellent heat conductor, and when it is used in parallel with a lead heat switch, it proves unnecessary to admit exchange gas during the precool period. The graphite exhibits a strong pumping action for helium gas at low temperatures. (auth)

4133 EFFECT OF CRYSTAL THICKNESS AND GEOMETRY ON THE ALPHA-PARTICLE RESOLUTION OF CsI(Tl). Prudencio Martinez and Frank E. Senftle (U. S. Geological Survey, Washington, D. C.). Rev. Sci. Instr. 31, 974-7(1960) Sept.

The resolution of CsI(Tl) for Po^{210} α particles was measured as a function of crystal thickness. The best resolution of a 0.5-in.-diameter cylindrical crystal was obtained for a thickness of 0.38 mm, and the effect of thickness on the resolution is discussed. Based on the proposed model, a conical crystal was designed which yielded a line width of 1.8% for Po^{210} α particles with a selected photomultiplier tube. (auth)

4134 SIX-METER RADIUS BENT-CRYSTAL SPECTROGRAPH FOR NUCLEAR GAMMA RAYS. A. H. Kazi, N. C. Rasmussen, and Hans Mark (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr. 31, 983-7(1960) Sept.

A 6-meter radius bent-crystal spectrograph for the pre-

cision measurement of nuclear γ-ray wavelengths was designed, constructed, and placed into operation. This instrument is particularly well suited for directly measuring neutron-capture γ rays produced by samples placed in the through port of the MIT research reactor. The spectrograph is designed to measure wavelengths of γ rays in the energy region from 0.1 to 4.0 Mev with an estimated precision that varies from about 0.01% at 0.1 Mev to 0.3% at 4 Mev. Photographic methods are used to record the γ-ray lines on the focal circle. A bent crystal is used to diffract and focus the γ rays. Line-width and efficiency data were obtained for the (310), (003), and (006) planes of quartz. The efficiency of the instrument is quite low. In order to record a line at 2.0 Mev, an exposure time of about 6000 curie hr is required. (auth)

4135 TRANSPARENT INDIUM CONTACTS TO CdS. Y. T. Sihvonen and D. R. Boyd (General Motors Corp., Warren, Mich.). Rev. Sci. Instr. 31, 992-4(1960) Sept.

Diffusion and sputtering techniques are described for applying low-resistance highly transparent antireflecting electrical contacts to CdS. The diffusion process entails heating CdS for several minutes in the presence of indium vapor. The resulting crystal surface resistance was adjusted to range as low as 12 ohms/square without any observable crystal discoloration. The sputtering process employs an 82 to 18% indium-tin alloy that is placed onto the crystal surface using oxygen as the sputtering atmosphere. The resulting film is Sn-doped In_2O_3, measuring 100 to 150 ohms/square, and showing 80 to 100% transmittance from 4600 to 20,000 A. (auth)

4136 FAST MAGNETIC FIELD SWEEP. G. W. Barton, Jr., L. F. Tolman, and R. E. Roulette (Univ. of California, Livermore). Rev. Sci. Instr. 31, 995-7(1960) Sept. (UCRL-5940-T).

A circuit for producing a magnetic field in a mass spectrometer is described. This field varies in triangular form at a rate of at least 1 cps with a magnitude of 500 gauss above a 1000- to 7000-gauss bias. The circuit uses a Varian V-4012 12-in. electromagnet and two Philbrick USA-3 operational amplifiers in place of the electromagnet's V-2100 power-supply amplifier. Diagrams are given of the circuitry, and some data on the performance of the sweep are tabulated as a function of the peak-to-peak sweep (gauss). (D.L.C.)

4137 VALVE FOR GLASS BLOWING ON CONTAMINATED APPARATUS. Harry Bleecher (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.). Rev. Sci. Instr. 31, 997(1960) Sept.

Glass-blowing operations can be performed on contaminated apparatus (e.g., gas-sampling apparatus used with toxic gases) without decontamination by means of the described valve device. In operation, the valve, actuated by the glass blower's oral pressure, regulates the pressure of an inert gas fed into the valve and thus adjusts the pressure inside the apparatus for glass blowing. (D.L.C.)

4138 TRANSISTORIZED LOCK-IN FOR KLYSTRON AUTOMATIC FREQUENCY CONTROL. A. J. George and D. T. Teaney (Univ. of California, Berkeley). Rev. Sci. Instr. 31, 997-8(1960) Sept.

A simple, highly reliable lock-in for klystron automatic frequency control is described which can be used with an unmodified commercial klystron power supply. The system is quiet enough for adequate stabilization with small amounts of klystron modulation, the noise being reduced by low-drain transistors and batteries. The system was used with success to stabilize an X-band klystron on a resonant cavity with only a 50-kc excursion of the klystron frequency, which is less than 5% of the microwave cavity and represents an electron spin resonance line broadening of less than 0.02 gauss. (D.L.C.)

4139 IMPROVED BRIDGE FOR LOW TEMPERATURE MEASUREMENTS. W. L. Briscoe (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr. 31, 999-1000(1960) Sept.

The resistance thermometer bridge of Blake, Chase, and Maxwell for low temperatures is modified to include a means for self-indication of the bridge null. The noise is very small at cryostatic temperatures. Use of an oil capacitor in place of an electrolytic capacitor for coupling the oscillator to the bridge gives improved performance. (D.L.C.)

4140 PULSING HALL PROBES FOR GREATER OUTPUT. Donald L. Shirer (Argonne National Lab., Ill.). Rev. Sci. Instr. 31, 1000-1(1960) Sept.

A method is described for increasing the Hall voltage of commercial Hall gaussmeters 10 to 20 times by pulsing the control current to higher values for precise measurements of low fields. Siemens FC33 probes, rated at a continuous control current of 0.1 amp, were pulsed at 1 and 2 amp at a duty cycle less than 1%, and the pulsing circuit is given. With a 1-amp current, the output of a probe is repeatable to within 0.03% with a 400-gauss magnetic field changing at a rate of 30 kilogauss/sec. This method of output boosting should be useful in situations where the instant at which a rapidly changing magnetic field passes through a certain value must be known with precision (e.g., the injection time of protons into a synchrotron) and should enable Hall probes to be competitive with peaking strips and nuclear resonance methods. (D.L.C.)

4141 TWO USES OF PROBABILITY PAPER IN SCINTILLATION GAMMA-RAY SPECTROSCOPY. Irving F. Boekelheide (Stanford Univ., Calif.). Rev. Sci. Instr. 31, 1001-2(1960) Sept.

Probability paper can greatly facilitate scintillation γ spectroscopy because plots of reliable peaks on such paper, as percentage of total counts vs. pulse height, show straight lines and can be used (1) to measure the internal consistency of the performance of the spectrometer electronic gear and (2) to determine the photopeak width at half-maximum. The relative slope of the straight line is a measure of the apparent line width or percentage energy resolution of the spectrometer. An example of this method is given in which the Cs^{137} γ spectrum as recorded by an NaI crystal is analyzed. (D.L.C.)

4142 THE COLLECTION OF LIGHT FROM SCINTILLATION COUNTERS. Richard L. Garwin (Columbia Univ., New York). Rev. Sci. Instr. 31, 1010-11(1960) Sept.

A discussion of the limits imposed by thermodynamics on the collection of light from scintillation counters by photocathodes is given, and a method for concentrating the light energy to any degree is pointed out. The method employs a fluorescent material to slightly reduce the photon energy and thus to emit fluorescence. A light pipe–fluorescent converter–light pipe arrangement for increasing light intensity is discussed. (D.L.C.)

4143 π^+ TRACKS IN A FILAMENT SCINTILLATION CHAMBER. G. T. Reynolds, R. A. Swanson, and D. B.

Scarl (Princeton Univ., N. J.). Rev. Sci. Instr. 31, 1011-13 (1960) Sept.

The performance of a filament scintillation chamber system designed for studies on stopping mesons was studied by exposing it to the 90-Mev π^+ beam of the Nevis cyclotron and taking a total of 16,000 photographs. The results indicate that (1) except for meson tracks, the chamber appears clean even without the 200-μsec gating and the iron blockhouse, (2) the magnetic field has no effect on the performance and resolution, (3) three or four tracks can appear in a single picture of the 1-in.-diameter chamber without confusion, and (4) even at the highest beam fluxes, the gating restricts the tracks to those selected by the counter system. Pictures of the distinguishable stopping of π^+ and π^- mesons are included. (D.L.C.)

4144 LOW-VOLTAGE HALOGEN COUNTERS (MECHANISM OF THE DISCHARGE). V. V. Vishnyakov, Hsiao-wei T'ang, and A. A. Tyapkin. Uspekhi Fiz. Nauk 72, 133-52(1960) Sept. (In Russian)

Low-voltage halogen counters, filled with neon containing small admixtures of argon (0.1%) and halide vapor (0.1%), offer a number of advantages over ordinary self-quenched counters, which contain an admixture of organic vapor. These include lower applied voltage (200 to 300 v.), ability to work at low temperatures (–80°C), practically infinite operating life, and recovery of counting characteristics after cases of continuous discharge. The mechanism of initial ionization and that of discharge quenching in low-voltage halogen counters differ fundamentally from those in ordinary counters. Certain of the basic principles are well-understood, but there is a need for a unified explanation of a number of phenomena peculiar to these counters. An investigation of the properties of a specific halogen counter in the regime of impulse voltage feed is described. This leads to a clarification of the role of negative ions. An analysis is then presented of the development in time of a non-self-sustained discharge. An expression for the impulse-regime efficiency, which essentially reproduces the experimentally observed effects of varying different parameters is the result. A mathematical description of the development of a self-sustained discharge is given. The predictions of efficiency and mean time delay of counts are compared with experimental data. Having obtained from analysis the dependence of the time delay on initial ionization, this gives the unexpected possibility of using halogen counters to measure the ionizing power of particles. The distribution of discharge delay time was studied as a function of counter voltage. Near threshold, the delay times become several tens of microseconds. This fact is used in the development of a mathematical description of threshold oscillations, which consist of repeated discharges appearing for a voltage near the counting threshold. (TTT)

4145 ARRANGEMENTS OF A THERMOELEMENT FOR THE MEASUREMENT OF FUEL ELEMENT TEMPERATURES. (to United Kingdom Atomic Energy Authority). German Patent DAS 1 068 392. Nov. 5, 1959. Atompraxis 6, 457-8(1960) Oct.-Nov. (In German)

A nuclear fuel element with magnesium-clad uranium fuel and a thermoelement cable that has a mantle of stainless steel which leads to a thermoelement connection in the uranium part is described. The novelty of the invention is that the thermoelement is embedded in the uranium and that at its exit from the uranium it is provided with a niobium or tantalum coating. The thermoelement should be sealed with a titanium cover over the lead through the cladding. (J.S.R.)

Materials Testing

4146 (WADC-TR-59-466) RESEARCH AND DEVELOPMENT LEADING TO THE ESTABLISHMENT OF ULTRASONIC TEST STANDARDS FOR AIRCRAFT MATERIALS. [Period] covered June 1958–June 1959. G. L. Cross, R. E. Kleint, and R. D. McKown. Wright Air Development Div. Ultrasonic Testing and Research Lab., Wright-Patterson AFB, Ohio. July 20, 1959. 151p. Project No. 7360. Contract AF33(616)-5877. (AD-142034). OTS.

Results of a study of materials and techniques concerning the evaluation of internal flaws by ultrasonic means are presented. The effects of variables on transmission of ultrasonic compressional waves in certain aircraft materials were examined along with the effects of material and geometrical variables on transmission of shear and surface waves in thin sheet materials. The quantities involved when altering the beam diameter by collimation are examined, and the correlation between the ultrasonic and mechanical properties of materials that contain quantities of minute porosity is considered. (auth)

4147 (Y-A3-132) NEW APPLICATIONS OF EDDY CURRENTS TO NONDESTRUCTIVE TESTING. Paul J. Long. Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn. Jan. 28, 1960. 30p. Contract W-7405-eng-26. OTS.

Paper presented March 7, 1960, before the meeting of the Southeastern Chapter, Society for Nondestructive Testing, Inc., Marietta, Georgia.

Practical applications of eddy-current testing are discussed. The use of eddy currents to detect worn areas in brass heat-exchange tubes and cracks in rolling mill rolls are described. A nomograph for eddy-current frequency selection is included. (C.J.G.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

4148 (AFOSR-TN-59-1214) NUCLEAR QUADRUPOLE RESONANCE IN IRRADIATED ORGANIC CRYSTALS AND IN A SEMI-CONDUCTOR-ELECTRON SPIN RESONANCE IN CARBONACEOUS ROCKS. Technical Scientific Note No. 1. Jules Duchesne, M. Read, and J. Depireux. Liège. Université. Institut d'Astrophysique. Jan. 31, 1960. 34p. Contract AF61(052)-167. (AD-236321).

The radiation resistance of organic crystals and a Cu_2O semiconductor to γ rays, x rays, and neutrons was studied by nuclear quadrupole resonance techniques. The origin of radioprotection phenomena and the behavior of the interactions between centers perturbed by irradiation were studied. The genesis of free radicals encountered in coals, peats, and petroleum is analyzed. Hypotheses concerning botanical origin and the effect of natural radioactivity are proposed. (C.J.G.)

4149 (TEM-836-C) "GRANITE" EXPLORATION HOLE, AREA 15, NEVADA TEST SITE, NYE COUNTY, NEVADA—INTERIM REPORT, PART C, PHYSICAL PROPERTIES. G. A. Izett. Geological Survey, Washington, D. C. Jan. 1960. 37p. OTS.

Physical-property measurements including porosity, density, permeability, magnetic susceptibility, and thermal conductivity were made on granite samples from the U-15A Granite exploration borehole, Nevada Test Site, Nye County,

Nevada. Porosity values range from 0.4 to 4.8%, and density values range from 2.56 to 2.69 g/cc (bulk density) and from 2.66 to 2.72 g/cc (grain density). Permeability of fresh rock from the borehole is probably less than 10^{-13} millidarcies. Magnetic susceptibility measurements range from 0.36 to 3.48×10^{-3} cgs units, and thermal conductivity values range from 5.6 to 8.1 cgs units. (auth)

4150 (AEC-tr-4228) THE ABSORPTION OF GAMMA RAYS BY SEDIMENTARY DEPOSITS. (O Pogloshchenii Gamma-Luchei Osadochnymi Porodami). L. S. Polak and M. B. Rapoport. Translated from Priklad. Geofiz., Sbornik Statei 15, 135-9(1956). 7p. JCL or LC.

The interaction of γ rays with mineral deposits is of practical interest in the interpretation of diagrams from radioactive core drilling and the application of a new experimental method of γ-γ core drilling that is based on registering the scattered γ radiation from a γ-ray source dropped in the core hole. The absorption of γ rays of average energies by sedimentary deposits is due to the Compton effect. The photoelectric effect and the formation of electron-positron pairs can be neglected. The absorption coefficient of γ rays of a definite energy is directly proportional to the density of an ore. The mineralogical composition of the ore does not affect this proportionality. The fact that the absorption coefficient of γ rays of a definite energy depends only on the density and not on the mineralogical composition of the ore can be utilized in interpreting γ-drilling diagrams and also in determining core-drilling densities, that is, in γ-γ-drilling. (W.L.H.)

4151 (SCL-T-337) EARTHQUAKE ENERGY, EARTHQUAKE VOLUME; AFTERSHOCK AREA, AND STRENGTH OF THE EARTH'S CRUST. Chuji Tsuboi. Translated by Noburu Hiraga (Sandia Corp.) from Zisin (4) 9, 276-80(1956). 10p. JCL.

Equations are derived to obtain a correlation between earthquake energy, earthquake volume, aftershock area, and the strength of the earth's crust. The way that the energy which is destined to become an earthquake is stored in the earth's crust is discussed. (W.L.H.)

4152 (SCL-T-340) ON THE CRUSTAL STRUCTURE AS DEDUCED FROM FORERUNNER ANALYSIS. Yoshimichi Kishimoto and Akira Kamitsuki. Translated from Zisin (2) 9, 200-8(1957). 10p. JCL.

A study devoted to determining the earth crustal structure in the western part of Japan is described. Analysis of forerunners (critical refracted waves which precede direct waves) which appear in close-distance earthquakes leads to a determination of the crustal structure. It is noted that the crustal structure varies greatly from one district to another. A close relation between the crustal thickness and the focal depth of earthquakes which occur in an area appears likely. (J.R.D.)

4153 THE IDEA OF AN "EPITHERMAL URANIFEROUS BED" AND THE PROBLEMS THIS RAISES. Jacques Geffroy and Jacqueline A. Sarcia. Bull. soc. geol. France (6) 8, 173-90(1958). (In French) (CEA-1136)

The abnormal character of the Limousin uraniferous veins with respect to classical hydrothermal veins is pointed out. A genetic theory is proposed: selective concentration of certain lithophilic elements by ordinary circulation, starting from hydrolyzed and tectonized zones or granitic batholiths. (auth)

4154 PRESENCE OF COFFINITE IN FRENCH URANIFEROUS DEPOSITS. Georges Branche and Bernard Morignat. Compt. rend. 248, 2358-60(1960) Apr. 20. (In French) (CEA-1238)

The characteristics are given of coffinite, a uranium silicate in which a part of the $(SiO_4)^{-4}$ is replaced by $(OH)_4^{-4}$. The main deposits are indicated. This is the first time that this uraniferous ore has been found in France. (auth)

4155 PRELIMINARY GEOLOGIC MAP OF THE CLIMAX STOCK AND VICINITY, NYE COUNTY, NEVADA. F. N. Houser and F. G. Poole. Geological Survey, Washington, D. C. Miscellaneous Geologic Investigations Map I-328. 1960. 2p. $1.50(USGS).

HEALTH AND SAFETY

4156 (A/AC.82/G/L.457) THE 90 STRONTIUM CONTENT OF THE DIET OF CHILDREN AND JUVENILES IN 1959. D. Merten and E. Knoop (Germany. Bundesforschungsanstalt für Milchwirtschaft. Physikalisches Institut, Kiel). July 20, 1960. 30p.

The effects of diet differences in Sr^{90} uptake by humans were considered in this study of Sr^{90} uptake by children. Consumption habits of children and juveniles were established, and the Sr^{90} contents of the principal foods were obtained. The amount of Sr^{90} offered in food of children was thus estimated at 8 to 13 pc per day at a level of approximately 13 pc Sr^{90}/g calcium. There was no significant difference when compared with contamination levels in diet of adults. (T.R.H.)

4157 (A/AC.82/R.103/Add.1) COMPUTATIONS OF DOSE FROM VARIOUS SOURCES OF RADIATION. United Nations. Secretariat. July 25, 1960. 8p.

Data regarding dose computations in occupational exposure are given. (T.R.H.)

4158 (A/AC.82/R.105) RADIOCARBON FROM NUCLEAR TESTS. United Nations. Secretariat. July 14, 1960. 56p.

A review is presented on distribution of C^{14} in the carbon cycle and the biological effects of C^{14}. Topics related to the former subject include distribution of carbon on the earth, production of natural C^{14}, distribution of natural C^{14}, movement of carbon in the carbon cycle, production of C^{14} by nuclear tests, experimental observations of increased C^{14} levels, inventory and present distribution of artificial C^{14}, and radiation dose from C^{14}. Topics reviewed as biological effects of C^{14} are relative biological effectiveness, spatial distribution of dose, effective dose rate, estimated consequences, duration of dose delivery, possibility of transmutation effect, and summary of position in respect of transmutation. (107 references.) (T.R.H.)

4159 (A/AC.82/R.105(Add.2)) SAMPLING AND MEASUREMENT OF CARBON-14 LEVELS IN THE ATMOSPHERE AND BIOSPHERE. (United Nations. Secretariat). Aug. 10, 1960. 5p.

A bibliography is offered on techniques and equipment for measurement of C^{14} levels in the atmosphere and biosphere. 36 references. (T.R.H.)

4160 (AD-239512) BIOLOGICAL AND MEDICAL ASPECTS OF IONIZING RADIATION. MEASUREMENTS OF RADIOACTIVITY IN MAN. Progress Report for July 1, 1959–July 1, 1960. C. O. Onstead, F. V. Keary, Jr., E. Oberhausen, and A. Pfau (Army Medical Research Unit No. 1, Landstuhl Army Medical Center, Germany). 10p.

The Landstuhl Human Counter has been in operation for one year. During that time more than 4000 people have been examined for Cs^{137} and potassium content. The data are being processed by means of an IBM computer. The counter has also been used to measure the radioactivity of individuals with known or suspected contamination. A special method of calibration for Ra^{226} measurements has been devised. Food samples have been studied. (auth)

4161 (CEA-1434) PROBLEMS DE MANIPULATION ET DE TRANSPORT. (Handling and Transport Problems). J. Pomarola and J. Savouyaud. France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay. 1959. 19p.

The handling and transport of radioactive wastes involves the danger of irradiation and contamination. It is necessary to lay down a special set of rules governing the removal and transport of wastes within centers or from one center to another and to give charge of this transportation to a group containing teams of specialists. The organization, equipment, and output of these teams are being examined. Certain materials are particularly dangerous to transport; and for these, special vehicles and fixed installations are necessary. This is true especially for the evacuation of very active liquids. A transport vehicle is described, consisting of a tractor and trailer and a container holding 500 liters of liquid of which the activity can reach 1000 C/l. The decanting operation, the route to be followed by the vehicle, and the precautions taken are also described. (auth)

4162 (CEA-1524) ETUDE DE MATERIAUX FILTRANTS ET D'APPAREILS DE PROTECTION A L'AIDE DES AEROSOLS RADIOACTIFS. (Study of Filterable Materials and Protection Instruments by the Use of Radioactive Aerosols). Billard, Chevalier, and Pradel. France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay. 1960. 26p.

Presented at the 5th International Colloquim on Industrial Pollen, Paris, March 19-21, 1959.

Many filtration problems can be studied by means of radioactive aerosols. For the investigations described, the solid disintegration products of radon, the radioactive gas formed from radium was chosen because of the facilities of generation and measurement it offers. Radon and its daughters are in fact always present in the atmosphere in sufficient concentration for certain tests. In order to improve the sensitivity of the measurements, radon from uranium ore can be used. The technique of measuring by counting α particles is rapid and easy to employ. Thus it is possible to define a test for filterable substances and to check filtering installations and individual protection instruments. (auth)

4163 (CRCE-981) TESTS ON COLLECTORS TO REMOVE IODINE FROM VENTILATION AIR. A. R. Bancroft, L. C. Watson, and R. Hewitt. Atomic Energy of Canada Ltd., Chalk River, Ont. Oct. 31, 1960. 41p. (AECL-1131). AECL.

Laboratory tests to evaluate the use of a number of materials for removing iodine from air streams indicated that charcoal was very effective (99.9%). Wire-mesh collectors offered the advantage of a much lower resistance to air flow as compared with charcoal, but the iodine-collecting efficiency for the two metals tested was lower than for charcoal. Silvered copper mesh indicated efficiencies generally higher than 99% for room-temperature air flowing at velocities as high as 5 ft/sec through 4- or 5-in.-deep beds of density 18 to 60 lb/ft^3. Copper mesh performed erratically, showing efficiencies from 99.8 to 15% and averaging 50% for 34 6-hr tests. Iodine concentrations from 10^{-7} to 134 mg I_2/m^3 air were tested. (auth)

4164 (JAERI-1011) MEASUREMENT OF RADIATION LEVEL OF THE 10 kc HOT CAVE. Report No. 11. (Japan Atomic Energy Research Inst., Tokyo). July 1, 1960. 46p.

The shielding of the 10-kilocurie Hot Cave at the JAERI was so designed that the maximum radiation intensity is less than 30 mr per 48-hr week (equivalent to 0.63 mr/hr) on any outside vertical wall and less than 150 mr per 48-hr week above the roof, when the 10-kilocurie Co^{60} γ-ray source is located at the center of the cell. The measurement of the field intensity was made by G-M and scintillation type survey meters. In the preliminary test using 500-c Co^{60} source, several weak points such as the manipulator through-tube and the shielding around the storage well were detected. To reduce the radiation leakage, an additional lead-shielding plug of 18 cm in thickness was inserted in a through-tube, and an iron shield box of 5 cm in thickness was attached around the tube at the hot side. For the storage cell, lead blocks of 10 cm in thickness were placed over the floor. After reducing the leakage of the shielding, radiation leak tests with 10-kilocurie Co^{60} source were carried out. The source was located at 70 and 175 cm above the floor at the center of each cell. The radiation levels on the outer surface of the cave did not exceed the specified limit except at two points, the manipulator through-tube and the periphery of the steel door on the roof. The distribution of the radiation intensity scattered from the manipulator through-tube with the lead shield of 38 cm in thickness was measured. Since this radiation is a very sharp directional beam, an operator may work under little influence of the scattered radiation. In general, the radiation levels at all positions outside the cave are at the safe level when the 10-kilocurie Co^{60} source is in use. (auth)

4165 (NAA-SR-4383) A STUDY OF SODIUM FIRES. J. D. Gracie and J. J. Droher. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Oct. 15, 1960. 90p. Contract AT-11-1-GEN-8. OTS.

A study of sodium fires was performed to obtain detailed information on their characteristics and behavior in order to develop techniques for preventing, containing, and combatting them. Investigation was made of the technology of sodium fires, design criteria for improving the fire resistance of equipment and installations using sodium as a coolant, extinguishing materials and procedures for fighting sodium fires, and the evaluation of protective equipment. (auth)

4166 (NACA-RM-E55123) TRANSPORTATION OF LIQUID FLUORINE. Paul M. Ordin (Lewis Flight Propulsion Lab., Cleveland). Nov. 8, 1955. Decl. Feb. 8, 1960. 17p.

In tests of a portable tank specially designed and constructed, liquid fluorine was safely transported and stored. The investigation included 82 hr of transportation in a total storage time of 2570 hr. (auth)

4167 (NP-9321) CODE OF PRACTICE FOR THE PROTECTION OF PERSONS EXPOSED TO IONIZING RADIATIONS. Part A: USE OF X-RAYS FOR DIAGNOSIS; USE OF X-RAYS AND γ-RAY BEAM UNITS FOR THERAPY. Part B: USE OF RADIOACTIVE ISOTOPES. Supplement: PROTECTION AGAINST IONIZING RADIATIONS—FUNDAMENTAL DATA. (Gt. Brit. Radioactive Substances Standing Advisory Committee). 1957. 86p.

A set of regulations and standard procedures is presented primarily intended for protection of persons exposed to radiation in hospitals in the National Health Service. Part A, use of x rays in diagnosis and x and γ rays in therapy, deals with regulations for survey of new installations, personnel qualification testing, and minimum requirements for equipment and procedures. Part B, use of radioisotopes, covers radiation surveys, personnel tests, describes hazards from sealed and unsealed sources, and gives rules for storage and movement of radioactive materials, protection of hospital personnel near patients being treated, and waste disposal. An Appendix is included on design and procedure for grade B laboratories. A supplement to the volume gives data on critical organs and effects, effective depth of critical organs, standard man, relative biological effectiveness, maximum permissible doses, and evaluation of shielding materials. (T.R.H.)

4168 (NYO-9528) STUDIES OF NUCLEAR DEBRIS IN PRECIPITATION. Progress Report No. 5. (Isotopes, Inc., Westwood, N. J.). Oct. 15, 1960. 41p. Contract AT(30-1)-2415. OTS.

Data are tabulated on the deposition of fall-out in the United States resulting from the Nevada test series; radioactivity in precipitation at Westwood, N. J.; the monthly deposition of Sr^{90} in stainless-steel pot collectors; determination of the age of nuclear debris deposited during the spring of 1960; the causes of variations in the rate of deposition of Sr^{90}; and the detection of nuclear debris from French atomic tests. (C.H.)

4169 (SC-4494(RR)) ENVIRONMENTAL BETA-GAMMA RADIO ACTIVITY IN AIR AT SANDIA LABORATORY, MAY 1959–DECEMBER 1959. H. L. Rarrick, R. E. Womelsduff, and A. Juskiewicz. Sandia Corp., Albuquerque, N. Mex. Oct. 1960. 16p. OTS.

Air samples were collected during the period May through December 1959. The filters were counted for β-γ activity. Data are presented graphically. (C.H.)

4170 (SC-4495(RR)) ENVIRONMENTAL BETA-GAMMA RADIO ACTIVITY IN AIR AT SANDIA LABORATORY, FIRST QUARTER 1960. H. L. Rarrick, R. E. Womelsduff, and A. Juskiewicz. Sandia Corp., Albuquerque, N. Mex. Oct. 1960. 10p. OTS.

Data are tabulated on the radioactivity of air samples collected at Sandia Laboratory during the first quarter of 1960. (C.H.)

4171 (SC-4496(RR)) ENVIRONMENTAL BETA-GAMMA RADIO ACTIVITY IN AIR AT SANDIA LABORATORY, SECOND QUARTER 1960. H. L. Rarrick, R. E. Womelsduff, and A. Juskiewicz. Sandia Corp., Albuquerque, N. Mex. Oct. 1960. 10p. OTS.

Data are tabulated on the radioactivity of air samples collected at Sandia Laboratory during the second quarter of 1960. (C.H.)

4172 (AEC-tr-4290) A STUDY OF THE RESULTS OF THE WINDSCALE ACCIDENT (OCTOBER 1957) AND OF THE VALIDITY OF SUTTON'S MATHEMATICAL MODEL OF ATMOSPHERIC DIFFUSION. (Etude des Consequences de l'Accident de Windscale (Octobre 1957) et de la Validite du Modele Mathematique de Diffusion Atmospherique de Sutton). J. J. Martin and A. Doury. France. Electricité de France, Paris and France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay. 1960. Translated from Report CEA-1538.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 20483.

4173 (CEA-tr-A-767) MESURE DISCONTINUE DE LA TENEUR EN AÉROSOLS RADIOACTIFS DE L'AIR. R. Neuwirth. Translated into French from Atompraxis 3, 372-7(1957). 22p.

Two discontinuous methods of air filtering are described, and a theory of electrostatic filters is offered. The first method consists of a fiber filter with a pump for drawing air through it. The filter collects radioactive aerosol particles which are thereby concentrated enough for radiometric determination. An electrostatic-filter arrangement for the same purpose is described, and extensive theoretical treatment of the electrostatic filter is presented. (T.R.H.)

4174 RADIATION MONITORING BY THE FILM BADGE METHOD IN RADIUM AND ISOTOPE LABORATORIES. H. Egelhaaft, H. Heinemann, and K. H. Seidler (Buchler & Co., Brunswick). Atompraxis 6, 407-11(1960) Oct.-Nov. (In German)

Film badges for monitoring purposes were exposed to radiation from sealed sources with Ra^{226}, Co^{60}, Cs^{137}, and Sr^{90} under various specified conditions. Evaluation was made by the "Study Group for Radiation Protection" in Erlangen. It was found that the dose values deviated more markedly from the applied doses than was hitherto known: upward by a maximum factor of 4.5 and downward by a maximum factor of 25. Thus this method is of doubtful reliability and usefulness for monitoring in radium and isotope laboratories. (auth)

4175 COMMENT ON THE EGELHAAF, HEINEMANN, AND SEIDLER ARTICLE "RADIATION MONITORING BY THE FILM BADGE METHOD IN RADIUM AND ISOTOPE LABORATORIES." F. Wachsmann (Universität, Erlangen, Ger.). Atompraxis 6, 411-13(1960) Oct.-Nov. (In German)

Contrary to the above quoted publication the author states that the accuracy of the gamma radiation measurements has again been proved by tests. The desirable accuracy of evaluation, however, cannot be obtained unless the film badges are used during the monitoring period only for which they were issued. In addition the indication both of type and quality of the radiation on the monitoring sheet is imperative. Measuring a β radiation below 200 kev as well as a radiation with a very oblique angle of incidence is impossible. Considering these facts, film badge monitoring proves to be definitely indicated also in isotope laboratories unless requirements are involved which other dose meters fail to meet as well. (auth)

4176 DETECTING A RELEASE OF "FRESH" FISSION PRODUCTS IN THE BIOSPHERE BY GAMMA SPECTROSCOPY. F. Habashi and T. Schönfeld (Universität, Vienna). Atompraxis 6, 414-15(1960) Oct.-Nov. (In German)

Gamma spectrometry measurements on evaporation residues of rain water collected in Vienna during March and April 1960 showed the presence of the relatively short-lived fission products I^{131}, Ba^{140}, and La^{140}. This must be attributed to the nuclear test explosions on Feb. 13 and Apr. 1, 1960, in the Sahara. Since no noticeable increase in the total (artificial) radioactivity was observed in Vienna in the aerosol (separation by filtration) and in rain water, these measurements show the suitability of γ spectrometry for detecting a release of "fresh" fission products to the biosphere. (auth)

4177 Cs^{137} POISONING IN ANIMAL FOOD OF MARIENSEE EXPERIMENTAL STATION IN 1959. A. Pfau and G. Kallistratos (Max-Planck-Institut für Tierzucht und Tierernährung, Mariensee/Trenthorst, Ger.). Atompraxis 6, 422-6(1960) Oct.-Nov. (In German)

With the help of a large radiation detector approximately 3 tons of agricultural products destined to be used as food for the livestock of the experimental field station of Mariensee (32 km northwest of Hanover) in the winter of 1959–60 were examined for their content of naturally occurring K^{40} and artificially produced Cs^{137} radioactivity. The examination of this animal food required only a few people and a small amount of time and resulted in no damage to the food. The purpose of the study was to determine the degree of contamination of animal food in the contamination chain: radioactive fallout—animal food—livestock—animal product—human being (1959). The measurement of animal foodstuffs grown mostly in Mariensee during 1959 showed that the ratio Cs^{137}/K^{40} for agricultural products grown beneath the ground and those grown above ground was at least 1 : 10. Since the specific potassium content remained nearly constant, agricultural animal food products produced in Mariensee in 1959 which grew beneath or just above the ground showed a smaller Cs^{137} contamination than those which grew further above the ground and were exposed to the atmosphere during the entire growing period. (auth)

4178 A MODIFIED METHOD FOR PERSONNEL MONITORING. I. HEMISPHERICAL FILTERS. II. AUTOMATIC DOSE ESTIMATION. P. G. Lale (Hammersmith Hospital, London). Brit. J. Radiol. 33, 748-56(1960) Dec.

In the first section, film badges are described which employ hemispherical filters for the measurement of exposure to x and γ rays. Two areas of measurement are used, one filtered and one unfiltered. By combining a proportion of one density to the other one may obtain either a flat response, or one following the back-scatter factor for large fields over the range 30 kev to 1.5 Mev in effective energy. The probable error of measurement is ±10% and the uncertainty for small doses is ±3 mr for Gevaert Dentus or ±6 mr for Ilford PM1 film. The second section describes an instrument for rapid measurement of the films, giving a direct reading of exposure dose. The contribution of soft or hard radiation can be obtained separately by depressing a switch. (auth)

4179 INTEGRAL DOSE AND HIGH ENERGY RADIATION. Giorgio Scarpa (Università, Rome). Brit. J. Radiol. 33, 770-5(1960) Dec.

A comparison has been made between the relative integral doses (ratio of integral dose to tumor dose) produced in tissue by beams of x and γ rays of different energies and by 15-Mev electrons. This comparison is markedly affected by the tumor depth and field size considered so that it is not possible to state in general that one radiation is preferable to another. For routine treatment conditions it would appear that the lowest relative integral dose will be achieved through the use of Co^{60} radiation for deep-seated tumors and by high-energy electrons for more superficial lesions. The use of x rays of energy appreciably above that of Co^{60} radiation appears to provide little or no advantage in this respect. (auth)

4180 FUNDAMENTAL PRINCIPLES OF RADIATION PROTECTION AND THEIR SIGNIFICANCE FOR THE 1st FEDERAL GERMAN DIRECTIVE. H. Holthusen. Deut. med. Wochschr. 85, 537-41(1960) Apr. (In German)

A discussion is presented of the role of international standards for radiation protection in formulation of the forthcoming First Federal German Directive. (T.R.H.)

4181 TRANSFERABLENESS OF X-RAY DOSE MEASUREMENTS FROM ONE SUBSTANCE TO ANOTHER. R. Glocker (Technische Hochschule, Stuttgart). Fortschr. Gebiete Röntgenstrahlen u. Nuklearmed. 93, 617-30(1960) Nov. (In German)

It is shown that with decreasing layer thickness of chamber walls an increasing fraction of the energy contained in the secondary electrons produced by x rays is dissipated outward. This has the effect that in the limiting case of infinitesimal layers the radiation effect is attributable only to the electrons originating in the surroundings. In this sense the dose measurement on infinitesimal layers can be considered as a measurement by a "probe". Dose measurements on infinitesimal layers do not necessarily meet the Bragg-Gray principle; in general such a measurement is therefore not transferable to a different substance. The conditions are discussed under which the concept of electron equilibrium may be applied to the ultra-hard x-ray range. The influence is calculated of the polarization correction on ionization measurements on betatron radiations of 15 to 30 Mev. The electrical calibration and volume determination of an air wall chamber which are required for the application of the Bragg-Gray principle may, under certain conditions, be replaced by a previous calibration in r-units, carried out under electron equilibrium conditions. (auth)

4182 DOSE DISTRIBUTION IN INHOMOGENEOUS MEDIA FOR IRRADIATION WITH FAST ELECTRONS. W. Pohlit (Max-Planck-Institut für Biophysik, Frankfurt am Main). Fortschr. Gebiete Röntgenstrahlen u. Nuklearmed. 93, 631-41(1960) Nov. (In German)

Systematic experimental investigations are carried out on the change of depth dose distribution of energetic electrons (25 Mev) in tissue (water) that takes place by embedded layers of bone (approximated by graphite). A very simple method is presented for calculating the displacement of the descendent part of the depth dose curve toward the skin, effected by bone, and into greater depth by lung tissue. In this way the dose distribution can be assessed for any practical case, also if the forementioned types of tissue are considered. (auth)

4183 A RAPID INDICATING INSTRUMENT FOR THE STEPWISE MEASUREMENT OF AIRDUST RADIOACTIVITY. J. H. Spaa (N. V. Philips' Gloeilampenfabricken, Eindhoven, Netherlands). Health Phys. 4, 25-31(1960) Oct.

This paper describes some operational experience acquired with an instrument for measuring stepwise the radioactive contamination of air-borne dust. To bring down the background due to the natural radioactive gases always present in air, the α- and β-activity of the dust deposit are measured during the accumulation period. As there is a fairly linear relation between the activities due to the natural radioactive gases, it is possible by means of a simple circuit to balance the α- and β-count-rates so that a zero reading is obtained if only natural radioactive gases are present, and a positive or negative reading is shown for a real β- or α-contamination, respectively. With a circuit so adjusted it proves to be possible with an air flow of 4 m^3/hr and a sample time of 12 hr to demonstrate during the accumulation period current normal levels of atomic bomb fallout (10^{-12}–10^{-11} $\mu c/cm^3$). Some discussion is devoted to the promising possibilities of using this instrument in plutonium laboratories to detect the MPC within several hours. (auth)

4184 SHORTER-LIVED FISSION PRODUCTS IN FALLOUT. G. M. Dunning (U. S. Atomic Energy Commission, Washington, D. C.). Health Phys. 4, 35-41(1960) Oct.

Calculations are made of the contribution of shorter-lived fission products in radioactive fall-out to the worldwide external γ levels. These are related to potential Cs^{137} radiation doses. Certain assumptions are necessarily used in the calculations, one of which is the mean residence time in the atmosphere. The potential theoretical dose from shorter-lived isotopes may vary from about 40% (mean or average life in the atmosphere, T_m = 10 years) to 1000% (T_m = 2 weeks) of the Cs^{137} dose. Estimates are also made of the worldwide total deposition of Cs^{137} from which calculations are made of the potential Cs^{137} doses. (auth)

4185 COBALT-60 BOMBS. G. M. Dunning (U. S. Atomic Energy Commission, Washington, D C.). Health Phys. 4, 52-4(1960) Oct.

Based on stated assumptions, the ratio of potential external energy releases from fission products in local fall-out compared to the Co^{60} that may be produced can vary from a factor of 40, based on an exposure period from 1 hr to 1 month after a detonation, to 0.17 based on an exposure period from the twenty-fourth hour to 35 years. It is concluded that other factors, i.e., fission yields and position of firing, would be more critical in determining the external γ hazard than the added Co^{60}. One megaton (total yield) detonated in the air might create enough Co^{60} to produce a theoretical total dose of 0.17 r in the most heavily contaminated band of the earth (30 to 60° north latitude), with weathering and shielding effects reducing this by as much as a factor of 10. Decontamination measures could reduce this dose further. Other doses may be calculated as a linear function of the tonnage assumed; thus the estimated doses could be significant in long-term effects but not lethal in the sense of wiping out a worldwide population. Mathematically an ever higher and higher assumed tonnage and Co^{60} production can be achieved until a lethal range is reached. (auth)

4186 DETERMINATION OF RADIOIODINE IN MILK AFTER A NUCLEAR ACCIDENT. A. H. W. Aten, Jr., H. J. L. Umans, and W. M. C. de Jong (Inst. for Nuclear Physics Research, Amsterdam). Health Phys. 4, 62(1960) Oct.

After the Windscale accident, the assay of milk for I^{131} content was carried out with scintillation counters. A survey was made of the shielding against environmental radiation provided for γ-counters of the G-M type inserted into a pipe closed at the lower end and introduced from the top into a full milk churn. The count rate from milk samples was found to be sufficient for accurate measurements after a few minutes of counting. (C.H.)

4187 A PORTABLE γ-DOSIMETER PROVIDING AUDIBLE WARNING. A. R. Jones (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Phys. 4, 64-7(1960) Oct.

The design of a portable γ dosimeter that alarms when a predetermined dose has been exceeded is described. The dose is measured by accumulating the charge, obtained from a saturated ion chamber, in a low-leakage condenser. When the voltage on the condenser rises to a set value, a regenerative circuit is triggered. This circuit then switches power to an oscillator driving a small loudspeaker. A circuit diagram and sketch of the mechanical arrangement is included. (C.H.)

4188 REDUCTION OF DOSES IN DIAGNOSTIC USES OF RADIOISOTOPES. F. Hosain (Saha Inst. of Nuclear Physics, Calcutta). Indian J. Med. Research 48, 250-6 (1960) Mar. (In English)

A moderately low-level counting technique with anticoincidence gas-flow counter was developed for use in metabolic and diagnostic tracer studies with radioisotopes. Several important experiments and results were reported which have been carried out with reduced doses of tracer isotopes. A reduction of the tracer dose of about $\frac{1}{30}$th of the present conventional doses was achieved which helps to minimize the chances of radiation hazards. (auth)

4189 BALLOON OBSERVATION OF ARTIFICIAL RADIOACTIVITY AT THE BASE OF THE STRATOSPHERE. H. T. Mantis and J. R. Winckler (Univ. of Minnesota, Minneapolis). J. Geophys. Research 65, 3515-19(1960) Nov.

On two ascents of a series of International Geophysical Year cosmic-ray balloon flights, layers of radioactivity were observed near the tropopause at Minneapolis, Minnesota. On Mar. 21, 1958, a specific activity of 0.8×10^{-5} disintegration/cm^3-sec was observed and on Oct. 31, 1958, the value was 0.4×10^{-5}. Upper-air trajectories were constructed for the events, and these, together with the mean energy, specific activity, and vertical profiles of the radiation, are consistent with the hypothesis that this radioactivity was produced by Soviet nuclear bomb debris about one week old. (auth)

4190 INVESTIGATIONS OF THE RADIOISOTOPES Be^7, P^{32}, AND S^{35} IN RAIN WATER. Rama (Tata Inst. of Fundamental Research, Bombay). J. Geophys. Research 65, 3773-6(1960) Nov.

The concentrations of the radioisotopes Be^7, P^{32}, and S^{35} in rainfall at Bombay and at Kodaikanal were measured. The average concentrations in rainfall at Bombay during the period from June 1959 to October 1959 were 2900 atoms/ml of Be^7, 12 atoms/ml of P^{32}, and about 400 atoms/ml of S^{35}. It is shown that the observed fall-out of Be^7 and of P^{32} is almost entirely of cosmic-ray origin; the fall-out of S^{35} may possibly contain an appreciable amount of bomb-produced S^{35}. (auth)

4191 RADIATION DOSIMETRY IN HIROSHIMA AND NAGASAKI ATOMIC-BOMB SURVIVORS. E. T. Arakawa (Oak Ridge National Lab., Tenn.). New Engl. J. Med. 263, 488-93(1960) Sept. 8.

This report summarizes the present state of knowledge in dosimetry of the survivors of the bombings at Hiroshima and Nagasaki. Data on the physical factors involved in the two cities and on attenuation of radiation by various shielding situations are presented. This information is being used to estimate a tentative radiation dose to individual atomic bomb survivors. It should be emphasized that many important problems remain to be solved before accurate doses can be assigned to individual survivors. Such information will greatly strengthen the investigation of biologic consequences of instantaneous doses of γ and neutron irradiation in man. (auth)

4192 THE MANAGEMENT OF VICTIMS OF RADIATION ACCIDENT. E. R. King (National Naval Medical Center, Bethesda, Md.). Southern Med. J. 53, 432-40(1960) Apr.

A method of caring for patients who have been exposed to a peacetime nuclear accident has been described. It should be apparent that the preparation for such an accident and experience of the medical team, if such an accident should occur, would better prepare the medical profession to cope with problems resulting from a nuclear attack. (auth)

4193 LIVING WITH RADIATION. 2. FIRE SERVICE PROBLEMS. The Problems of the Nuclear Age for the Layman. Francis L. Brannigan and George S. Miles. Office of Health and Safety, AEC. 1960. 137p. $1.00 (GPO).

Part II of "Living with Radiation" extends the discussion of the fundamentals covered in Part I into the area of fires and other emergency situations. It should be of interest not only to professional firefighters but also to those charged with the control of radiation hazards. It provides an insight into the problems that may arise in an emergency, and it should be useful in preplanning for the competent control of such situations. (auth)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

4194 (AD-240607) PROTECTIVE EFFECTS OF CERTAIN NATURAL FOODS AGAINST WHOLE-BODY IRRADIATION. Report No. 3 (Progress) for April 15, 1959–July 14, 1959. William J. Darby (Vanderbilt Univ., Nashville. School of Medicine). 16p. Project No. 7-84-13-002A. Contract DA19-129-QM-1307.

Progress is reported in studies on the effects of diet on radiosensitivity. The addition of mustard greens or broccoli to the basal diet of guinea pigs and rats for fourteen days before exposure to doses of 400 to 800 r x radiation increased the survival period slightly. Data are tabulated. (C.H.)

4195 (AD-240608) PROTECTIVE EFFECTS OF CERTAIN NATURAL FOODS AGAINST WHOLE-BODY IRRADIATION. Report No. 4 (Progress) for July 15, 1959–October 14, 1959. William J. Darby (Vanderbilt Univ., Nashville. School of Medicine). 15p. Project No. 7-84-13-002A. Contract DA19-129-QM-1307.

Progress is reported in studies on the effects of diet on radiosensitivity. Data are tabulated on the effects of the addition of broccoli, mustard greens, or green beans to the basal diet of rats, monkeys, and guinea pigs on survival after irradiation. (C.H.)

4196 (AD-240609) PROTECTIVE EFFECTS OF CERTAIN NATURAL FOODS AGAINST WHOLE-BODY IRRADIATION. Report No. 5 (Progress) for October 15, 1959–January 14, 1960. William J. Darby (Vanderbilt Univ., Nashville. School of Medicine). 14p. Project No. 7-84-13-002A. Contract DA19-129-QM-1307.

Progress is reported in studies on the effects of diet on radiosensitivity. Data are tabulated on the effects of the addition of mustard greens or broccoli to the basic diet on the survival of irradiated guinea pigs and rats. (C.H.)

4197 (JAERI-5002) ACTIVITIES IN THE HEALTH PHYSICS DIVISION IN JAERI (1960). Report No. 2. Japan Atomic Energy Research Inst., Tokyo. 292p.

Reports are presented on the following subjects: radiation control work, data on personnel exposure, release of radioactive wastes, background, accidents, blood studies, fundamental research, and development work. The fundamental research included shielding studies, external and internal exposure, decontamination, hazard analysis of reactor accident, transportation and diffusion of radioactive waste, and radiation monitoring and measurement. A meteorological and oceanographical survey is also reported. (T.R.H.)

4198 (NYO-2779) INVESTIGATION OF APPLICATIONS OF COMPTON BACKSCATTER. J. H. Tolan and W. T. McIntosh. (Lockheed Nuclear Products, Marietta, Ga.). July 1960. 43p. Contract AF(30-1)-2428. (NR-88). OTS.

An analytical study of detector yield as a function of source-collimator-detector geometry was conducted. The equipment to evaluate the principle of radiation thickness gaging by use of Compton backscatter was assembled and tested. Spectral response of three collimator-detector geometries was measured for radiation from Cs^{137} and Sn^{113} sources. Using the source-collimator-detector assembly yielding the highest signal-to-background ratio, inspection scans of simulated pipewall defects were made to evaluate maximum defect sensitivity of the probe. (auth)

4199 (QMFCI-18-59) RADIATION PRESERVATION PROJECT 7-84-01-002. Quarterly Status Report [for] February 1, 1959–April 30, 1959. Quartermaster Food and Container Inst. for the Armed Forces, Chicago. 35p. May 1959. (QMCAL-FRPD-8; AD-237077).

A summary and consolidation are presented of reports of contractors of the Quartermaster Corps' Radiation Preservation of Foods Project. (T.R.H.)

4200 (SSC-121) MANUAL OF ISOTOPE RADIOGRAPHY. Final Report. E. L. Criscuolo, D. Polansky, and C. H. Dyer (Naval Ordnance Lab., White Oak, Md.). May 23, 1960. 52p. Project SR-127. (AD-237536).

Information and experimental data on the radiography of steel (particularly welds) using isotopes are presented. This information may be useful to radiographers as a basis for selection of isotopes and exposure times to be used in any particular test. (J.R.D.)

4201 (TID-6955) USE OF RADIOACTIVE CALCIUM-45 TO DETERMINE THE SOURCE OF EXOGENOUS INCLUSIONS IN LOW-CARBON BEARING STEELS. Summary Report. E. J. Dunn, Jr., W. H. Schaefer, Jr., W. A. Buchovecky, J. M. Snook, and C. W. McCoy (Crucible Steel Co. of America, Pittsburgh). Sept. 15, 1960. 15p. Contract AT(30-1)-2291. OTS.

A method for impregnating Ca^{45} in a ladle nozzle was developed for a study of the contribution of refractory erosion to the total inclusion content of low-carbon bearing-steel manufacturing processes. The project was terminated, however, when the license granted by the U. S. Atomic Energy Commission was approximately 50 times less than the proposed radioactivity level and would not permit adequate identification of the inclusions resulting from nozzle wear because of the large mass of steel which would have to be dissolved to concentrate measurable isotope quantities. (auth)

4202 (TID-6956) USE OF RADIOISOTOPES IN THE STUDY OF METAL-TO-METAL WEAR OF HARDENED IRON-BASE ALLOYS. Quarterly Report No. 1. A. Talento and Gary Steven. Crucible Steel Co. of America, Pittsburgh. Apr. 15, 1959. 46p. Contract AT(30-1)-2291. OTS.

A literature survey was made on the friction and wear of solid metals and on autoradiographic techniques as they apply to metal-to-metal wear studies. When two contacting surfaces are moving with respect to one another, the asperities weld together to form weld junctions. The number of junctions is large when no foreign materials are on the contacting surfaces, but is greatly reduced by the presence of lubricants. Frictional forces are equal to the sum of the forces required to shear the weld junctions and the plough-

ing force. The rubbing surfaces may develop localized hot spots which may reach 2000 F, and in these areas the metal is plastically deformed. Frictional forces and wear usually decrease as the hardness of the specimens increases. Autoradiographic techniques have been used to determine the location of radioactive tracers. Because photographic emulsions are sensitive to ionization caused by products of atomic disintegration, they are used to record the radiation given off by radioactive tracers. The wet and dry autoradiographic techniques that have been developed for metallurgical applications are described in this report. (auth)

4203 (TID-6957) USE OF RADIOISOTOPES IN THE STUDY OF METAL-TO-METAL WEAR OF HARDENED IRON-BASE ALLOYS. Summary Report for January 1959–July 1959. Gary Steven. Crucible Steel Co. of America, Pittsburgh. 12p. Contract AT(30-1)-2291. OTS.

Radioisotopes of carbide-forming elements C^{14} and W^{185} are being added to tool-steel heats in an effort to adapt tracer techniques to structural examination of alloy steels. This method will ultimately be used to follow the microwear process of two metal surfaces rubbing against each other. As additional literature references pertaining to autoradiographic techniques in metallurgical investigations were reviewed, it became increasingly more apparent that high resolution (about 1μ particle size) must be attained in the nuclear-sensitive films. The scatter of radiation from the specimen surface is now the principal impediment to the achievement of sharp, high-magnification autoradiograms. (auth)

4204 (TID-6962) DETERMINATION OF THE UNIFORMITY OF MIXING OF PORTLAND CEMENT CONCRETE AND BITUMINOUS CONCRETE FOR VARIOUS MIXING TIMES BY THE USE OF RADIOISOTOPES. Quarterly Technical Status Report No. 3 Covering the Period June 1, 1960 to August 31, 1960. Donald O. Covault (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Sept. 10, 1960. 7p. Project No. A-446-7. Contract AT(38-1)-202. OTS.

A sampling and testing program to accumulate data by which the mixing uniformity of portland cement concrete may be determined has been in effect. One-hundred and fifty samples representing various mixing times from four mixes were obtained and partially processed. Strength cylinder and fineness modulus data from one plant in the Atlanta area indicate concrete strength to be dependent on mixing time and position in mixer. (auth)

4205 (TID-6963) KINETICS OF THE REACTIONS INVOLVED IN THE FERRIC CHLORIDE ETCHING OF COPPER PHOTOENGRAVING PLATES. Annual Technical Status Report No. 1 covering Period April 1, 1959 to March 31, 1960. W. H. Burrows (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Apr. 20, 1960. 27p. Project No. A-446-2. Contract AT(38-1)-202. OTS.

Values of the rate constants for the reaction were determined at temperatures of 25, 35, and 45°C over a range of concentrations from 0.5 to 3.5 M. At the lowest temperature a parabolic dependence of rate upon concentration is evident, whereas at higher temperatures the curve more nearly corresponds to a third degree curve. A relatively low temperature factor (ca. 1.25 av) indicates that in this temperature range the reaction is diffusion controlled. Certain irregularities observed may be due to mechanical defects in the apparatus and will be explored with revised equipment. Future studies are proposed for the investigation of the effects of various ionic and molecular additives to the etching bath. (auth)

4206 (TID-6972) CESIUM-137 RESEARCH IRRADIATOR. Annual Technical Status Report No. 1 Covering the Period April 1, 1959 to March 31, 1960. Randall W. Carter and Richard C. Palmer (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Apr. 10, 1960. 15p. Project No. A-446-6. Contract AT(38-1)-202. OTS.

A 12,000-curie, high-intensity Cs^{137} research irradiator was designed and installed on the Georgia Tech campus during the period covered by this report. The basic design is a slight modification of the Notre Dame Co^{60} irradiator with Cs^{137} as the active material rather than Co^{60}. The center sample hole has a homogenous radiation field through a vertical movement of 4 in., which will permit a homogenous dose to approximately 200 g of any material with a bulk density close to that of water. The dose rate in the center sample hole is 1.4×10^6 rads/hr. The twelve outer holes, although irradiated from one side only, present a fairly homogenous field to a sample over a length of 4 in. The dose rate in the outer holes is 7.5×10^5 rads/hr. (auth)

4207 (TID-6978) AN INVESTIGATION OF THE USE OF RADIOACTIVE ISOTOPES FOR DETERMINING THE SURFACE AREA OF POWDERED MATERIALS BY SORPTION METHODS. Quarterly Technical Status Report No. 4 covering Period: April 1, 1960 to June 30, 1960. Margaret C. Kordecki and Miriam L. Gandy (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). July 10, 1960. 10p. Project No. A-446-3. Contract AT(38-1)-202. OTS.

The technique developed in this project for surface-area determinations by radiostearic acid sorption was examined to determine the simplest sample-drying technique, the minimum sample-drying time, and the minimum sorbate-sorbent contact time that would be adequate for most types of powders. Samples of several powders (zinc sulfide, alumina, titania, sodium carbonate, and sodium bicarbonate) were dried by one of the following methods before determination of their surface areas: (1) in an oven at 110°C and atmospheric pressure; (2) in a vacuum oven at 120°C and 100 mm Hg; and (3) at 100°C and 100 mm Hg in a sample flask with a stopcock for adding the stearic acid solution without admitting air to the dried sample. Several different drying times were also compared. It was found that an inert powder such as zinc sulfide can be sufficiently dried in 2 hr at 110°C and atmospheric pressure. Basic powders, such as sodium bicarbonate, can react with stearic acid if traces of moisture are present, but they must be dried at low pressure in a flask (as described above) designed to exclude air from the dried sample. Materials with a great affinity for water must likewise be dried at reduced pressures and protected from contact with the atmosphere. Experiments designed to compare different times of contact between the dried sample and the stearic acid solution indicated that 1 hr is sufficient time to reach sorption equilibrium within the limits of experimental error. In an experiment comparing the sorption of stearic acid, $C_{18}H_{36}O_2$, with the sorption of lauric acid, $C_{12}H_{24}O_2$, on porous charcoal powder (with a BET value of 400 m^2/gm), the fatty acid sorption values for surface area were 61.7 and 63.6 m^2/gm, respectively. Apparently the shorter acid molecules could not penetrate the pores of the powder any better than could the longer ones. (auth)

4208 (TID-6979) AN INVESTIGATION OF THE USE OF RADIOACTIVE ISOTOPES FOR DETERMINING THE

SURFACE AREA OF POWDERED MATERIALS BY SORPTION METHODS. Quarterly Technical Status Report No. 5 Covering the Period July 1, 1960 to September 30, 1960. Margaret C. Kordecki and Miriam B. Gandy (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Oct. 10, 1960. 16p. Project No. A-446-3. Contract AT(38-1)-202. OTS.

Experimental work was conducted to determine the best solvents, plating techniques, and other details for surface area determinations with lauric acid-1-C-14 ($C_{12}H_{24}O_2$) and hexanoic acid-1-C-14 ($C_6H_{14}O_2$). The sodium salt of the latter was used in methanol solution, while both benzene and methanol solutions of lauric acid were used for determinations with high-surface carbon black and silica. Stearic acid sorption by the same samples was also determined in order to check the effect of carbon-chain length on the apparent surface area values obtained by fatty acid sorption. Also, a statistical treatment of the data obtained in determinations utilizing acids of different chain lengths was postulated to estimate pore-size distributions in high-surface powders. Cumulative plots were made of the number of carbons in the fatty acid chain vs. the percentage of pores under the size required to accommodate chains of the specified length. (The latter figure was calculated by dividing the difference between the Brunauer, Emmett, and Teller (BET) value and the fatty acid surface area by the BET value and multiplying by 100 per cent.) A calculation was also made of the approximate size of an idealized pore that would accommodate a perfectly fitted monomolecular layer of a fatty acid of known length. (auth)

4209 (AEC-tr-4267) DATA ON RADIOISOTOPE PRODUCTION. Translated from a publication of the Isotope Section of the Japanese Atomic Energy Bureau, Tokyo. Feb. 3, 1960. 15p. JCL.

The annual consumption of the major types of radioisotopes is presented in tabular form for 1950 to 1958. Anticipated amounts of the annual consumption of radioisotopes are estimated for 1959 to 1965. Data are presented on the future production plans and facilities of the Japan Radioisotope Association. (C.J.G.)

4210 (CEA-tr-R-893) VALEUR HYGIÉNIQUE DE LA POMME DE TERRE IRRADIÉE PAR LE COBALT RADIOACTIF POUR ARRÊTER LA GERMINATION. (Hygienic Quality of Potatoes Irradiated by Radioactive Cobalt to Prevent Germination). L. A. Okuneva (Okouneva). Translated into French from Voprosy Pitaniya 17, No. 5, 49-53 (1958). 11p.

After a review of progress in radiosterilization of potatoes, feeding experiments with radiosterilized potatoes are described. The potatoes were given doses of 10,000 or 50,000 r at 630r/min and fed to white rats and dogs. Daily observations were made of the general state, blood, enzymes, kidneys, liver, and reproduction function. At the end of the experiment, the animals were killed and examined pathologically and histologically. No pathological effect on the animals or their progeny was observed. (T.R.H.)

4211 (NP-tr-515) IRRADIATION OF GRAIN AND FLOUR IN BELGIUM. E. Maes, A. Deschreider, and G. Peeters. Translated by R. Todd (U.K.A.E.A. Atomic Energy Research Establishment) from Getreide u. Mehl 9, 117-19(1959). 12p. JCL.

After a brief review of studies in which the baking qualities of flour were improved by ultraviolet rays and h-f electric fields, a study with γ rays is described. Early tests using spent fuel rods as a source were prolonged and the dose rate was very low. A Co^{60} apparatus delivering 650 krad/sec was then used. The samples were irradiated in plastic bags to doses of 25 to 2000 krad and examined with attention directed to the following points: moisture, ash, protein, wet and dry gluten, diastatic power, test number, fermentation test, alveograph, farinograph, laborograph, and baking test. Solvent extraction for various components was also performed. It was found that soft wheat is improved more than hard. Gluten quality is improved. (T.R.H.)

4212 ELIMINATION OF DEAD TIME DURING THE COMPARISON OF MEASUREMENT VALUES IN THE VOLUME-THICKNESS MEASUREMENT WITH ISOTOPES. H. Langel (Frieseke & Hoepfner G.m.b.H, Erlangen-Bruck, Ger.). Atompraxis 6, 377-9(1960) Oct.-Nov. (In German)

A device for accumulating data with which a measurement value in the form of direct voltage can be transmitted after a certain dead time is described. The function of the device is illustrated by showing how it was used to improve the accuracy of a thickness-measuring system based on radioisotopes. As a further example of its application, it was used to reproduce a control track with a dead time and a time constant. (auth)

4213 UTILIZATION OF RADIATION DETECTION INSTRUMENTS IN THE OIL INDUSTRY. P. Gerke (Frieseke & Hoepfner G.m.b.H., Erlangen-Bruck, Ger.). Atompraxis 6, 380-5(1960) Oct.-Nov. (In German)

Density measurements are the top application problem for the use of radiation measuring apparatus in oil industry. The measuring principles, the mathematics involved, and applicable sources for industry are illustrated and the measuring method and its limits of sensitivity and accuracy are discussed with respect to the requirements of practical use. Data are given for measuring ranges covered and possible tube diameters. An example shows the possibilities of application in the monitoring of fuel pipelines. (auth)

4214 THE CHOICE OF DETECTORS IN THICKNESS MEASUREMENT OF RELATIVELY THICK MATERIALS. K. H. Waechter (Frieseke & Hoepfner G.m.b.H., Erlangen-Bruck, Ger.). Atompraxis 6, 358-91(1960) Oct.-Nov. (In German)

The stability of bremsstrahlung for measuring the thickness of materials such as those manufactured in cold rolling mills and the concept of sensitivity in such measurements are discussed. Experiments are reported on the use of scintillation counters with subsequent pulse-height analysis for technical measurements of thickness. Although the sensitivity P of such an arrangement appears to be greater, the arrangement does not meet the necessary requirements because of the large margin of error in measuring radiation intensity. The possibilities for improving the ionization-current yield of the ionization chamber for bremsstrahlung are also listed. The margin of error in measuring radiation intensity with such an ionization chamber is small enough to permit use of a measurement system with ionization chamber although there is hardly any increase in sensitivity. With this system material thicknesses can be measured within the prescribed narrow tolerances with a sufficiently short adjustment time. (auth)

ISOTOPE SEPARATION

4215 (CISE-81) PROGETTO ISOTOPICO DI UN IMPIANTO PER LA PRECONCENTRAZIONE DELL'ACQUA

PESANTE MEDIANTE DISTILLAZIONE DELL'ACQUA, PARTENDO DALLA CONCENTRAZIONE NATURALE. (Isotopic Design of a Plant for Pre-Concentration of Heavy Water by Distillation of Water, Starting with Natural Water). E. Cerrai, M. Silvestri, and S. Villani. Centro Informazioni Studi Esperienze, Milan. Sept. 1960. 133p.

The design is presented for a plant for initial concentration of heavy water from natural water. A capacity of 3000 kg of 50 mole % D_2O per year was sought, and the fractional distillation process was the most desirable. Geothermic steam is available in the Larderello region, and the possibility of recovery of boron from the water of this region is also present. Calculations are shown for separation factors and the effects of temperature. The criteria for establishing plant parameters and dimensions are outlined. Design studies for the columns are also reported. (T.R.H.)

4216 (CEA-tr-A-766) PROCÉDÉ RELATIF À L'EXTRACTION, SOIT D'EAU, SOIT D'HYDROGÈNE ENRICHIS EN DEUTÉRIUM, DE L'EAU ORDINAIRE. (Process for Extraction of Either Water or Hydrogen Enriched in Deuterium from Ordinary Water). F. Uhde. Translated into French from German patent 1030 818, June 16, 1956. 10p.

A process is presented in which a unique connection of a hydrogen-production plant and an HN_3 plant allows conversion of the H_2 to NH_3 and oxidation to NO_2 resulting in economy of operation. The electrolytic hydrogen, partiali enriched in deuterium, undergoes further enrichment in the other reactions. The condensed water vapor at each stage is recycled to the hydrogen-production plant. (T.R.H.)

4217 (CEA-tr-A-779) PRINCIPES ET TECHNIQUE DE LA MÉTHODE DE SÉPARATION DES ISOTOPES PAR ÉCHANGE CHAUD–FROID. (Principles and Technique of the Method of Separation of Isotopes by Hot–Cold Exchange). A. Schmidt. Translated into French from Atompraxis 5, 94-8(1959). 16p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 14114.

4218 (CEA-tr-X-214) PROCÉDÉ DE FABRICATION DE L'HYDROGÈNE, DE L'EAU LOURDE ET DE MÉTAUX. (A Process for Production of Hydrogen, Heavy Water, and Metal). L. Tronstad and J. Brun. Translated into French from Norwegian Patent 77 176, July 24, 1950. 27p.

A process is offered in which hydrogen and deuterium are produced by electrolysis, and the hydrogen is then used to reduce oxides or a mixture of oxides to metal or alloy. The hydrogen enriched in deuterium is oxidized by oxygen, and the hydrogen depleted in deuterium is used to reduce a metal oxide. The feed water for the electrolysis stage is pre-enriched by a catalytic exchange stage. The metal produced is the catalyzer. (T.R.H.)

4219 (CEA-tr-X-218) PROCÉDÉ DE CONCENTRATION DE L'EAU LOURDE. (Process for Concentration of Heavy Water). A. E. Knowles. Translated into French from Danish Patent 51747. [nd]. 6p.

An improved electrolysis process for D_2O concentration is offered in which the D_2O normally lost as vapor is recovered. The process uses tanks equipped for temperature control, sampling, electrolyte flow, condensers for recovery of condensate wash, and washers for washing the vapor with feed water. The water vapor in the electrolytic gases is condensed at each stage before the gases go to the next stage. The wash hydrogen is then contacted with feed water to further enrich the D_2. (T.R.H.)

MATHEMATICS AND COMPUTERS

4220 (NDA-2131-22) TABLES OF SOLUTIONS OF BESSEL'S DIFFERENTIAL EQUATION FOR USE IN ONE-GROUP REACTOR CALCULATIONS. G. Goertzel and R. Sullivan. Nuclear Development Corp. of America, White Plains, N. Y. Sept. 30, 1960. 27p. Contract AT(30-1)-2303(IX). OTS.

In diffusion-theory calculations in cylindrical geometry cylindrical functions are used which are linear combinations of Bessel's and Neumann functions for real and imaginary argument and of zero order. These functions and their logarithmic derivative are tabulated. A method for employing the tabulated functions in the one-group diffusion-theory calculation of multiregion cylindrical reactors is described. Use of the tables in obtaining region average flux and flux-squared values is discussed. Extension of the method to a solution by graphical means is described. (auth)

4221 (SCTM-16-60(81)) RANDOM SIGNAL ANALYSIS. P. T. Schoenemann (Sandia Corp., Albuquerque, N. Mex.). Aug. 1960. 40p. Contract AT(29-1)-789. OTS.

The theory underlying the analysis of random signals is investigated. The statistical significance of the power density spectrum is explained, and some of its uses are illustrated. A power density spectrum analyzer is outlined, and some of its errors and problems are discussed. (auth)

4222 (WAPD-TM-217) TRIP-1—A TWO-DIMENSIONAL P-3 PROGRAM IN X-Y GEOMETRY FOR THE IBM-704. E. Gelbard, J. Davis, J. Dorsey, H. Mitchell, and J. Mandel. Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh. July 1960. 25p. Contract AT-11-1-GEN-14. OTS.

The TRIP-1 program was designed to solve the one-group P_3 equations in XY geometry. It was used to investigate solutions to two-dimensional transport effects. The program is a modified version of PDQ-3. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

4223 (AD-234897) THE MANUFACTURE OF Ti–7Al–12Zr SHEETS. Bi-Monthly Report II [for] October 31, 1959–December 31, 1959. W. B. Aufderhaar (Mallory-Sharon Metals Corp., Niles, Ohio). 5p. Contract NOa(s) 59-6229-c.

Developments in the production of Ti–7 wt. % Al–12 wt. % Zr alloy in sheet form are reported. (C.J.G.)

4224 (AD-237340) A FUNDAMENTAL INVESTIGATION OF THE ALLOYING BEHAVIOR OF THE RARE EARTHS AND RELATED METALS. Semi-annual Progress Report No. 1 for Period: November 1, 1959–April 30, 1960. Albert S. Yamamoto, Charles E. Lundin, and Joseph F. Nachman (Denver. Univ. Denver Research Inst.). May 13, 1960. 17p. Project 7021. Contract AF33(616)-6787.

The Knudsen effusion apparatus was designed and constructed. Leak testing of the equipment components is being conducted. The calibration of the apparatus is now getting underway by the determination of vapor pressures of high-purity silver. The results of literature survey of rare-earth

vapor-pressure data are given. The procurement of the metals to be used in the first phase of the research program, i.e., praseodymium and neodymium of the highest possible purity available, is still in progress. (auth)

4225 (AD-239246) THE MANUFACTURE OF TI–7AL–12ZR SHEETS. Bi-monthly Report IV [for] February 29 to April 30, 1960. J. K. Dietzel, S. R. Seagle, and O. Bertea (Reactive Metals, Inc., Niles, Ohio). May 1960. 8p. Contract NOa(s) 59-6229-c.

A study was undertaken to determine the best production methods for producing the Ti–7Al–12Zr alloy in sheet form. This alloy is one of the newer α titanium alloys where minimum creep is desired. Data are reported on the mechanical properties of sheet produced by different rolling sequences. The effect of finish rolling temperature on the tensile properties of annealed and annealed and stabilized sheet is reported. (W.L.H.)

4226 (AMC-TR-60-7-807) BERYLLIUM FASTENERS. Final Technical Engineering Report [for] June 12, 1959–January 29, 1960. Edward F. Gowen, Jr. (Standard Pressed Steel Co., Jenkintown, Penna.). Aug. 1960. 74p. AMC Project 7-807. Contract AF33(600)-39728. OTS.

Lighter structures for high performance aerospace vehicles may be possible through the use of shear type bolts made from beryllium. On a strength-to-weight basis, beryllium bolts are stronger in all respects, but more costly than steel or titanium bolts of suitable configurations for similar applications. Room-temperature double-shear strength of bolt shanks was over 60,000 psi (65% of the strength of the base material tensile strength for beryllium vs. 60% for steel and titanium), which is equivalent to 400,000 psi for steel and 200,000 psi for titanium bolts on a strength-to-weight-basis. However, beryllium is not recommended for tension type fasteners because of its high degree of notch sensitivity. (auth)

4227 (ARF-2198-6) IMPROVED ZIRCONIUM ALLOYS—A SUMMARY OF RECENT WORK IN THIS FIELD; EURATOM PROGRAM. Interim Report. Daniel Weinstein and R. J. Van Thyne (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Nov. 8, 1960. 15p. Contract AT(11-1)-578, Project Agreement No. 1. OTS.

A brief summary is presented of present zirconium research at various organizations. (W.L.H.)

4228 (ARF-2198-7) EURATOM PROGRAM. "IMPROVED ZIRCONIUM ALLOYS." D. Weinstein and R. J. Van Thyne. Illinois Inst. of Tech., Chicago. Armour Research Foundation. Oct. 5, 1960. 11p. Contract AT(11-1)-578. OTS.

Research work on a program to develop zirconium-base alloys possessing superior strength and/or corrosion resistance in high-temperature water or steam is reported. Preliminary corrosion data were obtained for some Nb–Zr and Sn–Zr alloys exposed to 680°F water for 72 hr. A program was initiated to develop UN for power reactors. Initial efforts are being directed at developing a method by which high-purity, sound bodies of UN suitable for irradiation testing can be made. (W.L.H.)

4229 (GAMD-878) RECENT DEVELOPMENTS IN GRAPHITE. Walter L. Kosiba (General Atomic Div., General Dynamics Corp., San Diego, Calif.). July 17, 1959. 21p. Project No. 40.19. (MGCR-M-180). OTS.

Developments in the production of various graphite products and data on the properties, outgassing, and radiation resistance of various graphites are reviewed. (C.J.G.)

4230 (GEAP-3331) INDUCTION HEATED VACUUM HOT PRESS. Earl W. Hoyt. General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif. Revised Mar. 15, 1960. 10p. Contract AT(04-3)-189, Project Agreement No. 4. OTS.

Induction-heated vacuum hot-pressing equipment is described. The equipment operates at temperatures up to 2500°K and attains a vacuum of 10^{-6} mm Hg. Operation of the equipment is described. (C.J.G.)

4231 (JEN-68-DMe/I4) CONTRIBUCION AL METODO DE VAN ARKEL PARA LA PURIFICACION DE METALES. (Contribution to the "Van-Arkel Method" for Purification of Metals). J. Terraza Martorell, M. Lopez Rodriguez, and J. Diaz Diaz (Spain. Junta de Energia Nuclear, Madrid). 1960. 20p.

The process consists of the thermal decomposition of a volatile metallic compound by an incandescent filament on which the pure metal is deposited. The filament temperature is an essential point in the process development. From a theoretical point of view, curves were studied which determine the isothermic deposit of a metal. The process was divided in two parts; in the first, it was necessary to take into account variations in certain variables (emissivity, resistivity); in the second part, the deposition takes place in a similar way to one followed by an incandescent filament while vaporizing at a constant temperature. Graphs are given with the course of variables, which have to be used in an industrial development. The experiment was worked out for the particular case of zirconium deposited on tungsten. (auth)

4232 (NARTS-112) INVESTIGATION OF HIGH TEMPERATURE RESISTING MATERIALS AS UNCOOLED NOZZLES IN A LIQUID ROCKET ENGINE. W. F. Lehman. Naval Air Rocket Test Station, Lake Denmark, N. J. Apr. 1960. 45p. (AD-239249).

Materials were evaluated for use in uncoated rocket-motor nozzle components. A rocket engine was employed which was rated at 300 lb thrust and 300 psia chamber pressure. Red fuming nitric acid and unsymmetrical dimethylhydrazine were used as propellants. Samples tested were graphite, zirconium boride, titanium boride, fused silica, and two proprietary refractories. Performance data are included. (J.R.D.)

4233 (NP-9244) CONSIDERATIONS OF MATERIALS FOR USE IN NUCLEAR RADIATION HIGH TEMPERATURE ELECTRONIC COMPONENTS. G. A. Gallant (General Electric Co. Missile and Space Vehicle Dept., Burlington, Vt.). June 11, 1958. 37p.

A guide is presented to serve in the selection of materials for use in radiation tolerant electronic components and also to serve as a starting point in making further individual investigation on a particular problem in that it serves to gather definitions, basic effects, etc., into one document. It is intended to point out the mechanisms of radiation damage and the resulting type of damage, as well as its probable effect on the operation of electronic components. Where possible, it is intended to point out those materials known to be undesirable from the standpoint that their physical, chemical, or electrical properties are excessively degraded as a result of exposure to the various types of irradiation. A material reference listing known unclassified literature pertaining to the specific material is included for those desiring further radiation information on specific materials. The information was accumulated from all available sources, such as government reports,

General Electric Company reports, text-books, magazine articles, etc. (auth)

4234 (NP-9498) A FUNDAMENTAL INVESTIGATION OF THE ALLOYING BEHAVIOR OF THE RARE EARTHS AND RELATED METALS. Semi-annual Progress Report No. 2 [for] May 1, 1960–October 31, 1960. Albert S. Yamamoto, Charles E. Lundin, and Joseph F. Nachman (Denver. Univ. Denver Research Inst.). Nov. 1960. 12p. Contract AF33(616)-6787.

The Knudsen effusion apparatus was vacuum leak-checked. Considerable effort was expended in eliminating several minor sources of leakage. The system is now essentially leak free. The apparatus was then assembled to determine the vapor pressure of liquid silver, which is being used as a comparative standard. Preliminary data obtained so far indicate fair agreement with the published data. Several minor refinements in design and technique are being made as a result of these experiments. (auth)

4235 (NYO-2570) APPLICATIONS OF ULTRASONIC ENERGY. Progress Report No. 16 Covering Period from June 1, 1959–July 31, 1959. Aeroprojects, Inc., West Chester, Penns. Aug. 1959. 44p. Contract AT(30-1)-1836. OTS.

Using gelatin-stabilized kerosene-in-water emulsions as a simulant system, further experimental work with continuous-flow annular standing-wave treatment vessels resulted in agglomeration of a standardized emulsion. Consideration is now being given to the use of two annular treatment vessels operating in series. The tantalum crucible was incorporated into a high-temperature controlled-atmosphere ultrasonic-treatment furnace designed for the study of ultrasonic pyrometallurgical processes. These include promotion of phase equilibrium in the extraction of plutonium from molten uranium, increase in rate of dissolution of fissium in molten cadmium, and break up of oxide shells on fuel pins. Investigation of anion-exchange resins in ultrasonic-column operation was continued with further evidence of enhanced exchange rates. Exploratory tests with very dilute solutions to study the mechanism of ultrasonic diffusion through liquid films were initiated. By application of ultrasonic energy, the increases in flow rate of both stainless steel and ceramic slips through narrow orifices have been observed. Implications in slip casting of fuel-element plates as pins of narrow cross section are discussed. Evaluation of specimens on the basis of density and green strength will be used to assess the effect of ultrasonics applied during the casting process. Preliminary extrusion tests were made with alumina using ammonium alginate and water as plasticizer. When ultrasonic energy was applied to the die, there was an increase in the extrusion rate and a concomitant reduction in the extrusion load. It was also found possible to extrude at a reduced water content. (For preceding period see NYO-2569.) (auth)

4236 (WADC-TR-59-526(Pt.II)) PROTECTIVE COATINGS FOR REFRACTORY METALS. Period covered: September 1959 to June 1960. Clifton G. Bergeron, Victor J. Tennery, Arthur L. Friedberg, Doris M. Maroney, and Robert D. Shannon. Illinois. Univ., Urbana. July 1960. 54p. Project No. 7350. Contract AF33(616)-5734. OTS.

Various ceramic-coating systems for tungsten metal were developed and evaluated. These included silicide coatings, ceramic crystals in a glass matrix, zirconia-clad coatings, vapor-deposited SiO, and recrystallizing glasses. The system considered protective for tungsten at temperatures of 3000°F or higher, from a practical viewpoint, was a coating consisting of 35% glass and 65% zircon. Tungsten wire specimens coated with this glass-zircon coating were protected for 10 hr at 3000°F. A study of the nature of the degradation of this coating tested at 3000°F as a function of time was carried out based on microstructural observations and x-ray-diffraction analysis of the reaction products. (auth)

4237 (WAPD-ZH-25) ZIRCONIUM HIGHLIGHTS. (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 1960. 40p. Contract AT-11-1-GEN-14. OTS.

The tensile properties of Zircaloy-2 strip from various manufacturers and at various temperatures were investigated. A procedure is outlined for corrosion testing Zircaloy and hafnium coupons. A review is presented of the experimental evidence and engineering judgment upon which many requirements of corrosion testing techniques are based. The necessary operations are discussed in four groups: precleaning, pickling, rinsing, and autoclaving. (W.L.H.)

4238 (AEC-tr-4320) LOCAL ELECTROLYTIC POLISHING ("ELLOPOL" TECHNIQUE) FOR THE MICROSCOPY OF BERYLLIUM, ZIRCONIUM, AND MOLYBDENUM. (Polissage Électrolytique Local (Technique "Ellopol") pour la Métallographie du Béryllium, du Zirconium et du Molybène). Pierre-A. Jacquet. Translated from J. Less-Common Metals 1, 439-55(1959). 31p. (Includes original, 17p.). JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 14017.

4239 (NP-tr-495) INVESTIGATIONS OF THE DEPTH OF DEFORMATION PRODUCED BY THE PREPARATION OF METALLOGRAPHIC SECTIONS. F. Lihl and H. Mayer. Translated by L. F. Secretan (U.K.A.E.A. Atomic Energy Research Establishment) from Z. Metallk. 51, 186-90(1960). 19p.

An investigation was made of the preparation of metallographic sections relative to the amount and depth of deformation and its connection with surface roughness after grinding with papers of different fineness. Soft steel and electrolytic copper were used as specimens. Both wet and dry grinding methods were used. The surface deformation of sections polished electrolytically and using alumina was studied. (C.J.G.)

4240 (NP-tr-499) THE USE OF VACUUM IN METALLURGY. (Primenenie Vakuuma v Metallurgii). (Translation). 1958. Akademiya Nauk S.S.S.R. 241p. OTS.

Papers are included on the following subjects: the problems of the use of vacuum in metallurgy; the melting of transformer steel in vacuum furnaces; the influence of the melting method on the properties of stainless steel; some theoretical questions of vacuum metallurgy; the refining of metals and alloys by vacuum techniques; vacuum-arc melting of molybdenum; high-vacuum pumps and units; vacuum treatment of liquid steel in the ladle and its teeming in a protective atmosphere; results of research work on the application of vacuum in the teeming of alloy steel; the design of a vacuum installation for casting large ingots weighing up to 120 tons; the production of a compact ingot by carbon-free ferrochrome and metallic manganese by the method of vacuum refining; kinetics and mechanism of carbon-thermal reduction of chromium oxide in vacuo; vacuum method of preparing forging vanadium; and production of carbon-free ferrochrome by decarburization of carbon-containing ferrochrome in vacuo. (W.L.H.)

4241 PREPARATION OF UNIFORMLY DISPERSED OXIDES IN THE HYDROGEN–OXYGEN FLAME, AND SOME PROPERTIES OF THESE COMPOUNDS. R. Caillat, J. P. Cuer, J. Elston, F. Juillet, R. Pointud, M. Prettre, and S. Teichner (Commissariat a l'Énergie Atomique, Saclay, France and Faculté des Sciences, Lyon). Bull. soc. chim. France 152-6(1959). (In French) (CEA-1134)

A method for the preparation of solids in the form of nonporous spherical particles of homogeneous dimensions is developed. It makes use of a volatile derivative of the element which is decomposed in the flame of a hydrogen-oxygen blowtorch. (auth)

4242 NEW MICROGRAPHIC EXAMINATION METHODS FOR NUCLEAR METALS AND ALLOYS. H. Monti (Commissariat à l'Énergie Atomique, [Paris]). Métaux (Corrosion–Inds.) No. 400, 12p.(1958) Dec. (In French) (CEA-1170)

Several methods of preparation of specimens are described (polishing and pickling). Results obtained on the following metals are given: Pu, U, Th, Nb, Ta, V, Al–Pu, U–Pu, and Th–Nb. (auth)

4243 OUT-GASSING OF MATERIALS UNDER VACUUM. R. Geller (Centre d'Etudes Nucléaires, Saclay, France). Vide No. 74, 71-6(1958) Mar.-Apr. (In French) (CEA-1181)

After having studied outgassing of various rubbers at ambient temperature, together with araldite D, a study was made of other materials currently used in vacuum techniques, such as steatite, porcelain, Plexiglas, picein, brass, steel, and Duralumin. Finally, the influence of ambient temperature on the outgassing of Plexiglas and araldite was studied. (auth)

4244 IMPROVEMENTS IN OR RELATING TO CONTROL MEMBERS FOR USE IN NUCLEAR REACTORS. (to Westinghouse Electric Corp.). British Patent 850,999. Oct. 12, 1960.

Alloys for reactor control rods can be prepared of 65 to 85 wt. % Ag, 2 to 20 wt. % In, 0 to 10 wt. % Cd, 0 to 5 wt. % Sn, and 0 to 1.5 wt. % Al. Single-phase alloys of the above type were found to be corrosion-resistant to water, strong, and stable to neutron irradiation. They may be prepared according to the equation $X + 2Y + 3Z + 3W + 4V \leq 1.4$, where X, Y, Z, W, and V are the atom fractions of Ag, Cd, In, Al, and Sn, respectively. The preferred alloy for control rods comprises 80 wt. % Ag, 15 wt. % In, and 5 wt. % Cd. Data on water corrosion resistance at 500 to 650°F and effects of neutron irradiation on mechanical properties are given for some of these alloys. (D.L.C.)

Corrosion

4245 (BAW-1087) LIQUID METAL FUEL REACTOR EXPERIMENT. ZIRCONIUM NITRIDE FILM THEORY. Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va. Feb. 1960. 33p. Contract AT(30-1)-1940. OTS.

According to theory, the corrosion of certain steel alloys is inhibited by the formation of a protective film of ZrN, the nitrogen being present in the steel in the form of nitrides or in solid solution with the metal. The primary purpose of this investigation is to verify existing theory as applied to Croloy $2\frac{1}{4}$ by determining the level of nitrogen present in typical commercial heats, the effects of aluminum and of heat treatment on the nitrogen available for film formation, the minimum nitrogen necessary for film formation, and the effects of C, Mn, Si, N, and residual elements on film formation and retention. Samples from 21 commercial heats of Croloy $2\frac{1}{4}$ were analyzed to determine their nitrogen and aluminum contents. The concentration of nitrogen ran from 0.010 to 0.016%; aluminum, 0.008 to 0.037%. Other specimens from three representative heats were further tested by quenching from 1800°F and then reheating for 24 hr at temperatures from 750 to 1350°F. Analyses indicate that the metal loses a significant portion of its free nitrogen in the 1150 to 1350°F temperature range. A number of vacuum-melted alloys were prepared from ultra-pure materials for corrosion tests to determine the individual effects of minor alloying and residual elements. Owing to the termination of the project, only melting techniques, specimen preparation, and preliminary corrosion tests were completed. (auth)

4246 (BAW-1252) TILTING CAPSULE TESTS IN LMFRE FUEL SOLUTION. Final Report. E. J. Rozic (Babcock and Wilcox Co. Research Center, Alliance, Ohio). Apr. 1960. Changed from OFFICIAL USE ONLY Oct. 18, 1960. 74p. Contract AT(30-1)-1940. OTS.

Tilting capsule tests were conducted to provide information on the behavior of various materials in contact with uranium–bismuth solution at elevated temperatures. The majority of the tests were conducted at a ΔT of 225°F (750 to 975°F), a few at ΔT of 135 and 300°F. The level of additives to the uranium–bismuth solution was evaluated to determine how the level affected mass transfer characteristics of the test materials. The effectiveness of distinct heat treatments and various surface preparations was observed. (auth)

4247 (BAW-1253) LIQUID METAL FUEL REACTOR EXPERIMENT. LIQUID BISMUTH DYNAMIC CORROSION TESTS. R. E. Deville and W. R. Foley. Babcock and Wilcox Co. Research Center, Alliance, Ohio. June 1960. Changed from OFFICIAL USE ONLY Oct. 18, 1960. 335p. Contract AT(30-1)-1940. OTS.

To confirm the suitability of Croloy $2\frac{1}{4}$ as a material of construction for the Liquid Metal Fuel Reactor and to investigate Croloy $1\frac{1}{4}$ as a possible alternate material, liquid bismuth was pumped through $\frac{3}{4}$-in. Sch 40 pipe of these two materials at various temperatures, temperature differentials, and with various additives dissolved in the liquid bismuth. The conclusions of these tests may be summarized as follows. Croloy $2\frac{1}{4}$ and Croloy $1\frac{1}{4}$ are suitable materials of construction, zirconium added to the liquid bismuth inhibits container material corrosion. Corrosion specimens in the loop show that Croloy $1\frac{1}{4}$ is more resistant to corrosion by liquid bismuth than Croloy $2\frac{1}{4}$. Most corrosion attack was in the hot leg and was intergranular. With proper welding techniques, no preferential attack was noted in the weld metal. Surface preparation appears to have no effect on corrosion. Initial uranium and zirconium concentrations could not be maintained throughout the tests. Precipitation appears to be a function of temperature, so the problem can be eliminated by further work. Cavitation-corrosion effects caused rapid failure in the hot leg. Transported metal was usually found in the cold legs. (auth)

4248 (MND-E-2011) ERDL-NPFO. QUARTERLY PROGRESS REPORT NO. 13. C. Eicheldinger (Martin Co. Nuclear Div., Baltimore). Oct. 1960. 18p.

The first series of autoclave test runs was completed. The corrosion product film was removed from all test specimens by immersing in a boiling 25% sulfamic acid bath for 1 hr. Weight loss determinations were made for all specimens and a summary of the results is included; 576 were used. Statistical analysis of the weight loss data

was started. Microscopic examination of the autoclave test specimens revealed no cracking or pitting. Corrosion loop modifications were completed. Hydrostatic tests of the loop and functional tests of the power equipment were successfully completed. All loop controls were checked out. It was necessary to use 5% sulfamic acid solution to clean the loop prior to testing. The primary loop was successfully cleaned in this manner. During pressurization of the primary loop, in preparation for cleaning the secondary systems, the pressurizer-heater burned out. A new heater assembly was ordered. In the interim period, argon gas pressurization will be attempted. Fabrication of the following vessels was completed: MOD SG-7 and SH-7 (Inconel), MIN-15 and -16 (bimetal), MIN-12, -13, and -14 (Monel) and MIN-17, -18, and -19 (nickel). Welding specifications for Inconel, Monel, and nickel are near completion. (auth)

4249 (NAA-SR-Memo-2414) INVESTIGATION OF VARIABLES AFFECTING BELLOWS LIFE IN LIQUID SODIUM. J. S. McDonald (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 27, 1958. 20p. OTS.

Bellows are used in valves and other components in sodium graphite reactors at and below 1000°F. A study was made of the variables which can affect the life of bellows in sodium systems. A study was also made to determine which variable can be investigated experimentally. (W.L.H.)

4250 SOME OBSERVATIONS ON THE INTERACTION OF LIQUID SODIUM WITH CAST IRONS AND PLAIN CARBON STEELS. A. A. Smith and G. C. Smith (Univ. of Cambridge, Eng.). J. Iron Steel Inst. (London) 196, 29-42(1960) Sept.

The decarburizing action and allied effects of molten sodium on ferrous materials were investigated, and it is shown that decarburization by sodium depends on the presence of a sink in which the carbon removed from the specimen may be deposited. Cast irons are rapidly penetrated by the sodium, and modification of the microstructure in the interior of the specimen may result, even where there is no removal of carbon from the iron. The formation of surface layers and crystals was noted on steels immersed in sodium and was ascribed to the transport of material from the container in which the test was carried out. Some measurements were made on the rate of decarburization of plain carbon steels by sodium over the temperature range 600 to 850°C, and the results were correlated with the iron-carbon phase diagram and the diffusion rates of carbon in ferrite and austenite. (auth)

4251 APPARATUS FOR STUDYING THE CORROSION OF STAINLESS ALLOYS IN AQUEOUS MEDIUM AT HIGH TEMPERATURE. E. Pouillard (Compagnie des Forges de Châtillon, [Paris]), H. Coriou, and M. Grall. Métaux (Corrosion–Inds.) No. 401, 16p.(1959) Jan. (In French) (CEA-1145)

A novel method developed for studying the corrosion of stainless alloys at high temperature is described. "Microautoclaves" which fill the function of receptacle for the attacking medium and test piece were fabricated. Two types were developed: one for examining surface corrosion and the other for examining stress corrosion. These "microautoclaves" are inexpensive, easy to mass produce, and their smallness in size allows them to be introduced into reactor canals for studying the effect of irradiation on the phenomena of corrosion. Examples of investigations carried out using these microautoclaves are described. (auth)

4252 ACTION OF MOLTEN HALIDES OF NICKEL, COPPER, IRON, AND CERTAIN STEELS. E. I. Gurovich. Zhur. Priklad. Khim. 33, 2096-2101(1960) Sept. (In Russian)

Following up the author's previous studies with alkali chlorides (Zhur Priklad. Khim. 24, 425-32(1954) No. 4), the corrosive action of molten fluorides at 800, 850, and 900°C on various metals was investigated. In the eutectic mixture containing 30.4 wt. % NaF + 69.6 wt. % Al, with a melting point of 685°C, Armco iron was found to be slightly more resistant than the other metals tested on the basis of the weight loss vs. exposure time curve. The formation of a protective fluoride or oxyfluoride film was noted on the surface of nickel and copper. In molten KBr and KI, the steel and the nickel specimens exhibited the highest resistance, followed by iron, while copper was strongly attacked. The behavior of iron in the latter melt seems to indicate also the formation of a protective film. Considering the behavior of all the molten halides included in the study (see above reference), the weight loss varied from 0.8 to 72.5 $g/m^2/hr$, with KCl being the least and LiCl the most corrosive melt. For nickel, iron, and stainless steel, the Cl^- was found to be least and the F^- ion the most corrosive, while for copper the Br^- ion was most corrosive. At higher temperatures the order changes for most metals, but iron retains the original order in aggressive behavior: $Cl^- < Br^- < I^- < F^-$. (TTT)

Fabrication

4253 (AD-236858) MACHINING CHARACTERISTICS OF HIGH STRENGTH THERMAL RESISTANT MATERIALS. ITEM V, PART II. MACHINING CHARACTERISTICS OF MOLYBDENUM–0.5% TITANIUM ALLOY. Report No. 90 for January 1, 1960 to April 30, 1960. Wright Aeronautical Serial Report No. MP.00-210. Leonard J. Nowikowski (Metcut Research Associates Inc., Cincinnati). 78p. For Curtiss-Wright Corp. Wright Aeronautical Div., Wood-Ridge, N. J. Contract AF33(600)-35967.

The machining characteristics of a molybdenum alloy containing ½% titanium were studied relative to turning, face milling, drilling, reaming, and tapping operations. The data for the various machining tests are presented in graphical form to show the relationships between tool life, cutting speed, feed, tool geometry, tool material, and cutting fluids. Grinding tests were conducted to determine the effect of grinding wheel grade, wheel speed, down feed, cross feed, and table speed on grinding ratio and surface finish. The data for these studies are presented in graphical form to show grinding ratio as a function of grinding variables. Results of individual tests including surface finish data are shown in tabular form. Force measurements were made for turning and drilling the Mo alloy. The data are shown in graphical form to indicate the effect of machining variables on unit power, coefficient of friction, and tool forces. (auth)

4254 (AD-239276) COLUMBIUM-BASE MATERIALS. Final Report [for] May 19, 1957 to August 31, 1959. F. V. Lenel and L. J. Regitz. Rensselaer Polytechnic Inst., Troy, N. Y. 69p. Project Nos. 438.51 and 438.64. Contracts NOas 57-739-d and NOas 59-6047-c.

As a first step in the development of a dispersion-strengthened niobium-base material, a technique was developed wherein relatively coarse particles of metallic niobium were hydrided and ball-milled to a very fine particle size. This powder was compacted, and the resulting compact was dehydrided and then sintered to a

high density by the simultaneous application of pressure and high electrical current. The dense compact may serve as a billet for hot working by extrusion. Suitable apparatus was developed for hydriding, ball-milling, compacting, dehydriding, and resistance sintering niobium in such a way that impurity pickup, particularly the pickup of interstitial impurities such as oxygen and nitrogen, was minimized during processing. Attempts were made to develop a technique for extruding small niobium billets by heating them by electrical resistance and simultaneously extruding them through a steel die with a tungsten insert. This development work was not advanced sufficiently to determine its ultimate feasibility or whether more conventional methods of extrusion should be considered. In order to produce dispersion-strengthened niobium-base materials, the technique developed must be modified so as to combine the ball-milling of the brittle niobium hydride with the mixing of the hydride with an insoluble, nonreactive, and finely divided second phase and by performing the subsequent processing steps using this mixture. Some of the considerations in the choice of a material for a second phase are discussed. (auth)

4255 (BAW-1098) LIQUID METAL FUEL REACTOR EXPERIMENT. INVESTIGATION AND TESTING OF WELDED AND BRAZED MOLYBDENUM JOINTS. Final Report. R. E. Pavlak. Babcock and Wilcox Co. Research Center, Alliance, Ohio. Apr. 1960. Changed from OFFICIAL USE ONLY Oct. 18, 1960. 37p. Contract AT(30-1)-1940. OTS.

Tungsten-arc-welded butt and lap joints, connecting molybdenum-to-molybdenum and molybdenum-to-Croloy 2¼, were inspected for soundness and tested to determine tensile and bend properties at various temperatures. In duplicate tests, the molybdenum was alloyed with ½% titanium. The feasibility of brazing was also investigated. Molybdenum-to-molybdenum and molybdenum-to-Croloy 2¼ joints (joined with various silver, nickel, and gold compounds) were tensile-tested at room temperature. (auth)

4256 (DMIC-Memo-69) WELDING OF COLUMBIUM AND COLUMBIUM ALLOYS. W. J. Lepkowski, R. E. Monroe, and P. J. Rieppel (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Oct. 24, 1960. 31p. OTS.

Data on various methods of welding niobium and niobium alloys are compiled and reviewed. 16 references. (C.J.G.)

4257 (HW-61797) DEVELOPMENT OF RIBBED JACKET TUBING FOR PRTR. R. C. Aungst. General Electric Co. Hanford Atomic Products Operation, Richland, Wash. Sept. 4, 1959. 15p. Contract AT(45-1)-1350. OTS.

Development of ribbed tubing for use in the Plutonium Recycle Test Reactor is reported. A machine was developed that welds either longitudinal or spiral ribs to thin-walled Zircaloy tubing, and a method was devised for coextruding rib shapes and a tubular section. Techniques for welding ribs to thin-walled jacket tubing and for the direct extrusion of ribbed tubing are being developed. (J.R.D.)

4258 (NAA-SR-Memo-5600) THE CASTING OF 0.100 INCH THICK URANIUM ALLOY FUEL PLATES. E. Carpenter (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 10, 1960. 14p. OTS.

A process was investigated for casting uranium alloy fuel plates 0.100 by 3 in. wide by 12 in. long. The alloy used for the investigation was U–3.5 wt. % Mo–0.5 wt. % Si. (W.L.H.)

4259 (NMI-4852) DEVELOPMENT WORK ON THE FABRICATION OF CP-5 FUEL ELEMENT TUBES. Final Report. J. Wong (Nuclear Metals, Inc., Concord, Mass.). May 13, 1960. 51p. For Argonne National Lab. Contract AT(30-1)-1565, Sponsor Agreement No. S-58. OTS.

Problems encountered in the fabrication of Argonne Research Reactor fuel element tubes are discussed. (C.J.G.)

4260 (NP-9405) PRESENTATION DU FILM SUR LA FABRICATION DES ELEMENTS COMBUSTIBLES DE LA PILE G2. (Film Presentation on Fabrication of Fuel Elements for the G2 Reactor). Gauthron and Nadal. France. Commissariat à l'Énergie Atomique. [Centre d'Etudes Nucléaires, Saclay]. Aug. 17, 1959. 4p. (DM/782).

The procedure for fabrication of uranium, cladding, and plugs and final assembly of G-2 fuel elements is described as presented in a motion-picture film. (T.R.H.)

4261 (NP-9406) FABRICATION DU 3ÈME JEU D'ELEMENTS COMBUSTIBLES DU REACTEUR EL.3). (Fabrication of the Third Loading of Fuel Elements for the EL-3 Reactor). de Lasteyrie, Doumerc, and Guibert. France. Commissariat à l'Énergie Atomique. [Centre d'Etudes Nucléaires, Saclay]. Sept. 4, 1959. 28p. (DM/794).

After a brief description of the EL-3 Reactor and its fuel elements, the fabrication of the fuel elements for the third loading is described. The process has five steps: melting and casting, vacuum treatment, electron-beam seal welding, hot cladding, and testing. (T.R.H.)

4262 (NP-9487) COLUMBIUM AND COLUMBIUM ALLOY EXTRUSION PROGRAM—A STATE-OF-THE-ART SURVEY. Interim Report 1. A. W. Dana, Jr., C. C. McBride, F. J. Anders, Jr., and W. J. Barnett (Du Pont de Nemours (E. I.) & Co., Wilmington, Del.). June 30, 1960. 105p. Contract AF33(600)-40700.

The state of the art of the extrusion of niobium base alloys is reviewed. The extrusion process is reviewed as a complete manufacturing process. In addition to the extrusion process itself, billet preparation techniques, mechanical and physical properties of extruded stock, and factors such as oxidation resistance that might affect both extrusion and postextrusion operations are analyzed for five selected alloys. (W.L.H.)

4263 (ORO-330) FUEL BEARING FIBERGLAS IN ALUMINUM BASE FUEL ELEMENTS. Monthly Progress Letter No. 16 [for] Period September 1, 1960–September 30, 1960. R. H. Baskey (Clevite Corp. Mechanical Research Div., Cleveland). Oct. 12, 1960. 3p. Contract AT(40-1)-2557. OTS.

Progress is reported on a program to develop procedures which utilize aluminum-coated, fuel-bearing Fiberglas as core material in aluminum-clad fuel elements. The fabrication of compacts by hot-pressing and rolling is reported. Tensile tests of as-hot pressed, uranium-bearing Fiberglas were conducted. Stress-rupture tests were conducted on fuel plates clad with Alclad 6061 and Alclad 5154. (W.L.H.)

4264 (WAL-TR-648.4/1) DEVELOPMENT OF HIGH WELD-JOINT EFFICIENCIES IN A WORK-HARDENING STAINLESS STEEL. William P. Hatch, George M. Orner, and Warren C. Malatesta (Watertown Arsenal Labs., Mass.). Oct. 1960. 70p. DA Project No. 5B93-32-001. OTS.

Work-hardened stainless steels are attractive for missile work because their properties include high strength in

conjunction with corrosion resistance and relatively good low-temperature toughness characteristics. However, welds in these materials characteristically have low tensile joint efficiencies when tested in the as-welded condition. In this investigation, techniques involving cold-work at subzero temperatures were utilized to obtain joint efficiencies approaching 100% with acceptable levels of ductility and notch-toughness in the welds. (auth)

4265 (AEC-tr-4300) STRENGTH OF WELDED CONNECTIONS ON CYLINDRICAL CONTAINERS. H. Heusler. Translated for Oak Ridge National Lab. from Schweissen u. Schneiden 11, 315-18(1959). 18p. (Includes original, 4p.). JCL.

The strength of various weld connections on cylindrical containers with static and pulsating stresses is determined. Construction designs of container connections are studied and their advantages and disadvantages are discussed. The applicability of narrow pipe spacing is considered. (C.J.G.)

Properties and Structure

4266 (AD-234895) THE MANUFACTURE OF HEAT TREATABLE Ti-6Al-4V, Ti-2.5Al-16V AND Ti-8Al-8Zr-1 (Cb + Ta) TITANIUM SHEET. Bi-monthly Report No. XXI. P. E. Moorhead, W. B. Aufderhaar, and S. R. Seagle (Mallory-Sharon Metals Corp., Niles, Ohio). Feb. 1960. 16p. Contract NOa(s) 56-994-c.

The mechanical properties of Al-Ti-V alloys at room temperature are reported. Processing and welding of Ti-8 wt. % Al-8 wt. % Zr-1 wt. % (Nb + Ta) alloys were studied. (C.J.G.)

4267 (AD-235517) CHROMIUM BASE ALLOYS. Progress Report No. 51 [for] January 1, 1960–March 1, 1960. Howard Levingston, Raymond Cairns, Ole Sandven, and Nicholas J. Grant (Massachusetts Inst. of Tech., Cambridge). 6p. Contract NOas 60-6022-c.

The solid solution and second-phase strengthening of chromium-base alloys is being investigated. The physical and mechanical properties of high-strength Cr–Nb alloys are being determined at various temperatures. (W.L.H.)

4268 (AD-236286) PRODUCTION OF EXTRUSION BILLET OF HIGH TEMPERATURE AIRCRAFT ALLOYS BY POWDER METALLURGY. PHASE II. Second Interim Engineering Report for Period December 7, 1959–April 7, 1960. M. W. Toaz (Clevite Corp. Mechanical Research Div., Cleveland). Project No. Nr 7-764. Contract AF33 (600)-39327.

Extrusion billets of Armco Steel's PH 15-7 Mo (Cr–Fe–Mo–Ni alloy) and General Electric's René 41 (Al–Cr–Co–Fe–Mo–Ni–Ti alloy) were prepared by powder metallurgy techniques. Billet fabrication was investigated relative to billet heating by induction or resistance, lubricants, reduction ratios of 8:1, 12:1, and 16:1, and consolidation by either hydrostatic or cold press. Green powder billets of a density 60 to 70% of that of the wrought material were extruded to densities only slightly below or, in many cases, equal to those of the wrought material. The grain size of the extruded René 41 alloy was about two to three times finer than that found in equivalent forged wrought material. Tensile strengths in the René 41 powder billet extrusions were comparable to those reported for cast and wrought material. (C.J.G.)

4269 (AD-237110) EFFECTS OF ELEVATED TEMPERATURES ON MECHANICAL PROPERTIES OF TYPE H-7213 MICARTA (ASTROKON). Technical Report No. 2 [of] Project: EFFECTS OF HEATING ON THE PROPERTIES OF HOMOGENEOUS AND HETEROGENEOUS MATERIALS. S. Y. Lu and William A. Nash (Florida. Univ., Gainesville. Engineering and Industrial Experiment Station). May 1960. 17p. Contract DA-01-009-ORD-656.

The effects of rapid heating to ~1200°F (in 15 sec) on the mechanical properties of type H-7213 Micarta were studied. (C.J.G.)

4270 (AD-238003) DEVELOPMENT AND PRODUCTION OF IMPROVED MOLYBDENUM SHEET BY POWDER METALLURGY TECHNIQUES. Interim Report No. 3 [for] March 1, 1960–April 30, 1960. Russell C. Nelson, Roger B. Bargainnier, and Charles Wurms. Sylvania Electric Products Inc. Chemical and Metallurgical Div., Towanda, Penna. May 3, 1960. 47p. Contract NOas 60-6018-c.

With the exception of elevated-temperature tests, the evaluation of dispersion hardening agents added to molybdenum by dry blending was completed. Of the three refractory oxides added in various concentrations by weight, TiO_2 raised the recrystallization temperature by 100°F over that obtained with ZrO_2 and Al_2O_3 additions. These latter additions apparently had no effect on raising the recrystallization temperature above that of unalloyed molybdenum. Increasing percentages of oxide additions had an inverse effect on room temperature formability of as-rolled sheet. A stress-relief anneal improved formability. Wet-doping methods (22 variations) of adding dispersion hardening agents are in process based on the purest raw material paramolybdate. In addition to the three additives mentioned previously, ThO_2, Cr_2O_3, Ti, and ZrO_2 + Ti are under investigation. In the development of process specifications, the effect of variations in sintered density on edge cracking in sheet was illustrated. The sintered density of the slab prior to rolling apparently had no effect on the control of finished sheet properties. The finished sheet properties were a result of the rolling schedule. The trend reported previously, that sintered density increased with increasing slab size, was shown to exist. However, since the variations were small and within those experienced from lot to lot, the study was discontinued. Further work was done on unalloyed molybdenum in optimizing the rolling procedure and setting up test equipment for material evaluation. In the powder-rolling feasibility study, some 5- to 10-mil molybdenum sheet was produced which had room-temperature properties comparable to sheet produced by standard techniques. Investigation continued on finding an optimum metal powder, proper rolling speeds and powder flow, sintering, and rerolling. Further attempts were made at producing a Mo–0.5% Ti alloy by adding TiH_2. (auth)

4271 (AD-238301) RESEARCH ON THE OXIDATION BEHAVIOR OF TUNGSTEN. Quarterly [Progress] Report for the Period March 1, 1960–April 30, 1960. (Report No. 8). Rudolph Speiser. Ohio State Univ. Research Foundation, Columbus. May 27, 1960. 7p. Project No. 831. Contract AF33(616)-5721.

Progress reported includes a study of the W–O systems at low oxygen pressures. Preliminary data on the properties of WO_2, $W_{18}O_{49}$, and $W_{20}O_{58}$ were obtained. Techniques for preparation of oxide samples to be used in electric conductance and Hall measurements were developed, and the necessary apparatus was constructed and calibrated. (J.R.D.)

4272 (AD-240435) PARAMETRIC STUDIES OF METAL FIBER REINFORCED CERAMIC COMPOSITE

MATERIALS. Bimonthly Report No. 3, [for period] May 8, 1960–July 7, 1960. Elbridge Z. Stowell and Tien-Shin Liu (Southwest Research Inst., San Antonio). July 8, 1960. 14p. Contract NOas 60-6077-c.

The strength of composite materials when stressed at an angle to the fiber reinforcements is considered in terms of the angles involved and certain strength properties of the fibers and the matrix. A discussion is made on refractory oxides at high temperatures. (auth)

4273 (AD-240639) DEVELOPMENT OF TUNGSTEN-BASE ALLOYS. Interim Report No. 3 covering Period May 1, 1959 to July 15, 1960. M. Semchyshen and Robert Q. Barr. Climax Molybdenum Co. of Michigan, Detroit. July 15, 1960. 32p. Contract NOas 58-847-c.

Seven tungsten-base alloys were arc-cast. The alloy additions were added to the consumable tungsten electrode at increasing rates, producing compositionally graded ingots. By this technique, tungsten-base binary-alloy ingots with cobalt, hafnium, tantalum, vanadium, or zirconium have been produced successfully. Attempts to arc-cast ingots of tungsten with nickel or silicon failed owing to the high vapor pressure of these alloying elements at the melting point of tungsten. The tungsten-base binary alloys which have been cast successfully have been evaluated with respect to macrostructure, microstructure, hardness at room temperature and at 1600°F, lattice parameter, and oxidation rate at 2000°F as a function of alloy addition. (auth)

4274 (ARF-2095-1) TRANSFORMATIONS IN URANIUM-BASE ALLOYS. Summary Report [for] December 14, 1955–March 31, 1957. S. J. S. Parry, F. C. Holtz, and R. J. Van Thyne. Illinois Inst. of Tech., Chicago. Armour Research Foundation. June 28, 1957. 195p. ARF Project B 095. For Westinghouse Electric Corp. Bettis Plant. Contract AT-11-1-GEN-14, Subcontract No. 73-(14-432). OTS.

Transformation kinetics of binary U–Nb and ternary U–Nb-base alloys were investigated. Additions included zirconium, chromium, titanium, silicon, nickel, ruthenium, and vanadium. Encapsulated samples were given a homogenization anneal at 1000 or 1100°C, water-quenched from 900°C to retain the γ phase, and reheated to temperatures between 360 and 600°C. The metastability of the γ phase was examined by metallographic, hardness, resistometric, dilatometric and x-ray-diffraction techniques. The U–Nb system is characterized by a monotectoid decomposition of the high temperature γ allotrope at about 645°C to form α and γ_2, a niobium-rich cubic structure. Decomposition in U–Nb and in most U–Nb–X alloys occurred by a continuous precipitation of α from the body-centered cubic γ phase with a resultant enrichment in niobium of γ until the equilibrium γ_2 composition was reached. In the U–Nb–Ti and U–Nb–V systems, α and γ_2 were coprecipitated. Annealing at 550 and 600°C produced decomposition products which, in most materials, originated at the grain boundaries; a fine precipitate which initiated throughout the matrix was observed at lower annealing temperatures. Increasing the niobium content resulted in greatly increased stability. The following elements added to a U–Nb base were found to retard transformation of the γ phase: zirconium, chromium, ruthenium, and vanadium. Additions of titanium, silicon, and nickel produced alloys which were less stable than the U–Nb base to which they were added. Cold-working a U–7 wt. % Nb–2 wt. % Zr composition caused a more rapid transformation upon annealing at 360 and 450°C, and the resulting microstructures were different. Continuous cooling transformation studies were conducted on U–10 wt. % Nb materials, solution annealed at 700 and 950°C, and cooled at various linear rates to temperatures between 300 and 600°C. Cooling rates between 8.5 and 14.5°C per minute were required to prevent transformation of the γ phase, depending upon the prior melting techniques and thermal history. (auth)

4275 (ARF-2187-5) DUCTILE BERYLLIUM ALLOYS. Bimonthly Report No. 5. Frank A. Crossley and R. J. Van Thyne. Illinois Inst. of Tech., Chicago. Armour Research Foundation. July 20, 1960. 15p. Contract NOas 60-6036-c. (AD-240614).

An envelope type microstructure prepared by liquid-phase sintering is being investigated as a means of producing ductile beryllium alloys. Sinterability has been demonstrated previously for 25 vol. % matrix alloys of the Be–Al–Ge and Be–Ag–Ge systems, so efforts were directed toward developing alloys of lower matrix content. Previous work has given considerable evidence that matching hardness of the matrix with the principal phase is mandatory for high ductility compacts. Accordingly, quaternary additions for strengthening the matrix were investigated. The most promising alloy system is Be–Ag–Al–Ge. The hardening reaction in the silver-rich matrix of this alloy system is a peritectoid reaction $\alpha + \gamma \rightarrow \beta$. Slow cooling from above the peritectoid reaction temperature of 390°C, or quenching from above this temperature and aging below it, results in hardnesses up to three times higher than those achievable in the Ag–7.5 wt. % Cu age hardening alloy. Alloys of Be–Ag–Al–Ge systems nominally containing 10 and 15 vol. % matrix were liquid-phase sintered under pressure to eliminate voids. Pressure sintering apparently squeezed out some of the matrix so that the resulting compacts contained less than 10 vol. % matrix and probably about 5 vol. %. The compacts were very tough. This was especially evident in abrasion cutting. Two compacts were cold reduced 60% although cracking initiated at 18% reduction. These alloys are standouts among those investigated to date. They show real promise. (auth)

4276 (ARF-2191-3) IMPROVED VANADIUM-BASE ALLOYS. Bi-monthly Report No. 3. B. R. Rajala and R. J. Van Thyne (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 27, 1960. 14p. Contract NOas 60-6056-c. (AD-240003).

Promising V–Nb base alloys are being investigated since they exhibit excellent elevated temperature strength. A complete listing of alloys prepared with sheet fabrication procedures employed is given. V–Ti–Nb alloys containing from 0 to 70 wt. % niobium were fabricated to 0.050-in. sheet by either warm or cold working; no more than two intermediate anneals were required. Tensile testing was conducted at room temperature, 2000, and 2400°F; specimens were protected by an inert atmosphere at the elevated temperatures. Welding studies were conducted on V–5 wt. % Ti- 20 wt. % Nb alloy. The room-temperature properties of the weldment were similar to those observed for the parent material. Specimens with no post-weld heat treatment passed a 2t bend test at room temperature. (auth)

4277 (ARF-2191-5) IMPROVED VANADIUM-BASE ALLOYS. Bimonthly Report No. 5 [for] August 1, 1960–September 30, 1960. B. R. Rajala and R. J. Van Thyne. Illinois Inst. of Tech., Chicago. Armour Research Foundation. Oct. 26, 1960. 9p. Contract NOas 60-6056-c.

Promising V–Nb alloys are being investigated because they exhibit most of the properties desired in high-temperature materials. Fabrication of ½-in.-thick slab

from the vacuum-induction-melted ingots was achieved by upset-press forging at 2400°F. Tensile testing was conducted at 1800 and 2200°F in a helium atmosphere. Optimum strength at elevated temperatures was achieved with the addition of 5% titanium to the V–20 Nb alloy. Short-time stress-rupture properties were determined for several alloys at 2200°F. Bend-test data for various vanadium alloys indicated excellent formability. (auth)

4278 (BMI-1472) DETERMINATION OF INTERSTITIAL SOLID-SOLUBILITY LIMIT IN TANTALUM AND IDENTIFICATION OF THE PRECIPITATE PHASES. Dale A. Vaughan, Oliver M. Stewart, and Charles M. Schwartz (Battelle Memorial Inst., Columbus, Ohio). Oct. 28, 1960. 30p. OTS.

Solid-solubility limits at 1500, 1000, and 500°C for carbon, nitrogen, and oxygen in high-purity tantalum were determined by x-ray lattice-parameter methods. For carbon, the solubility was found to be 0.17 at. % at 1500°C and less than 0.07 at. % at 1000°C. A nitrogen solubility of 3.70 at. % at 1500°C decreased linearly with temperature to 2.75 at. % at 1000°C and 1.8 at. % at 500°C. In the case of oxygen, the solubility was found to be 3.65 at. % at 1500°C, 2.95 at. % at 1000°C, and 2.5 at. % at 500°C. The phases Ta_2C, the low-temperature modification of Ta_2O_5, and Ta_xN of unknown composition but which has a superlattice structure based upon the original body-centered-cubic tantalum lattice were identified as the initial precipitates in the respective systems. (auth)

4279 (CAL-PI-1273-M-6) AN INVESTIGATION OF THE THEORETICAL AND PRACTICAL ASPECTS OF THE THERMAL EXPANSION OF CERAMIC MATERIALS. Quarterly Progress Report. Kenneth M. Merz (Cornell Aeronautical Lab., Inc., Buffalo). Mar. 15, 1960. 11p. (AD-235034).

The thermal expansion of the two-phase ceramic compositions $MgO-MgO \cdot Al_2O_3$ and $Al_2O_3-MgO \cdot Al_2O_3$ was studied. These compositions were studied because no intermediate compounds form in either system and elasticity data are available for all three phases. Thermal expansion measurements were made with a fused-quartz dilatometer. A heating rate of 3°C/min from room temperature to 1000°C was maintained. Results of the observed thermal expansion are reported. (W.L.H.)

4280 (DEG-Report-120) URANIUM CERAMICS DATA MANUAL. PROPERTIES OF INTEREST IN REACTOR DESIGN. B. J. Seddon (United Kingdom Atomic Energy Authority. Development and Engineering Group, Risley, Lancs, England). Mar. 7, 1960. 68p. BIS.

A compilation is presented of the best available unclassified data on the physical, mechanical, and chemical properties of UO_2, UC, U_3Si, and U_3Si_2. (W.L.H.)

4281 (DMIC-136A) THE EFFECTS OF ALLOYING ELEMENTS IN TITANIUM. VOLUME A. CONSTITUTION. D. J. Maykuth, H. R. Ogden, and R. I. Jaffee. Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio. Sept. 15, 1960. 233p. Contract AF18(600)-1375. (PB-151094). OTS.

Reasonably complete information is available on the constitution and structure of binary and ternary alloys of titanium. Reliable partial or complete phase diagrams were determined for 37 binary titanium alloy systems. In addition, some solid-solubility data and information on intermetallic compounds were obtained in 14 other binary titanium alloy systems. Similarly, alloy-constitution data are available for 67 ternary titanium alloy systems. Almost half (33) of these are concerned with a study of interstitial-element (oxygen, nitrogen, carbon, and hydrogen) combinations, either alone (11 systems) or in combination with substitutional alloying additions (22 systems). Phase-diagram information was obtained on most of the ternary alloy systems of commercial interest, e.g., Ti-Al-Mo and Ti-Al-V. Unfortunately, much of the work with ternary Ti-Al-base alloys was carried out before ordering in the titanium-rich α phase of Ti-Al alloys was recognized. Consequently, a good understanding of the effects of ternary alloy additions on the structure of Ti-Al-base alloys is not yet available. (auth)

4282 (HW-64815) PREFERRED ORIENTATIONS IN EXTRUDED ZIRCALOY-2 TUBING. J. J. Laidler (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 15, 1960. 48p. Contract AT(45-1)-1350. OTS.

Texture studies were made on specimens of extruded Zircaloy-2 tubing having different fabrication histories. Pole figures are plotted and interpreted. Predictions are made concerning behavior of the tubes under varying loading conditions, based on the observed textures. (auth)

4283 (HW-64971) ULTRASONIC GRAIN SIZE TESTING OF HANFORD FUEL ELEMENTS. C. L. Frederick (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 11, 1960. 18p. Contract AT(45-1)-1350. OTS.

An ultrasonic grain size test apparatus is described for measuring the grain size of individual uranium cores. The apparatus uses digital techniques and provides a readout of finest, average, and variation in grain size. Through correlations of test data with metallographic examination, tentative limits are defined for large, small, and variation in grain size. Operation and performance of the testing apparatus are discussed. (C.J.G.)

4284 (NAA-SR-Memo-2576) THE EFFECT OF CARBIDE PRECIPITATION AND CARBURIZATION ON THE MECHANICAL PROPERTIES OF TYPE 304 STAINLESS STEEL. O. C. Shepard (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 11, 1958. 9p. OTS.

An investigation was made of the possible carbide precipitation and carburization of the surface of stainless steel in a sodium system. Stainless steel at temperatures as low as 850°F becomes carburized in sodium contaminated with carbon. Carburization of stainless steel in sodium takes place mainly by grain-boundary diffusion in the 750 to 1000°F temperature range, while at 1200°F and above volume diffusion predominates. Mechanical property tests of type 304 stainless steel which has been carburized in sodium at volume diffusion temperature range show increased strength and reduced ductility. (W.L.H.)

4285 (NAA-SR-Memo-3012) PRELIMINARY ANALYSIS OF DIFFERENTIAL PRESSURE SAFETY DEVICES. R. Holland (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 6, 1958. 10p. OTS.

The feasibility of using differential pressure techniques for triggering power reactor safety devices was investigated. Preliminary investigations show that it is feasible to develop a power reactor safety device that is triggered by differential pressure techniques. Three methods of creating the differential pressure were considered and are reported. (W.L.H.)

4286 (NAA-SR-Memo-3645) DETERMINATION OF THE COEFFICIENT OF FRICTION BETWEEN GRAPHITE AND 304 STAINLESS STEEL. L. Newcomb. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Mar. 10, 1959. 3p. OTS.

The static coefficient of friction between graphite and type 304 stainless steel varied from 0.252 to 0.269 in an uncontrolled environmental atmosphere at 80°F. In a clean atmosphere, the coefficient varied from 0.199 to 0.206. (C.J.G.)

4287 (NAMC-AML-AE-4198, Pt.1) THE INFLUENCE OF BORON, TITANIUM, ALUMINUM, AND ZIRCONIUM ON THE HIGH TEMPERATURE PROPERTIES OF Fe–Cr–Ni ALLOYS. William A. Sipes (Naval Air Material Center, Aeronautical Materials Lab., Philadelphia). May 4, 1960. 11p.

An investigation was conducted to determine the effects of minor additions of boron, zirconium, titanium, and aluminum singly or in combination on the high-temperature properties of Fe–Cr–Ni alloys. Details of the tests are given, and a discussion of results and conclusions is included. (J.R.D.)

4288 (NMI-1225) PRELIMINARY ATTEMPTS TO PRODUCE RANDOMLY ORIENTED WROUGHT BERYLLIUM AND THEIR RELATION TO TEXTURE DEVELOPMENT. F. M. Yans and P. Pointu (Nuclear Metals, Inc., Concord, Mass.). July 6, 1960. 53p. Contract AT(30-1)-1565. OTS.

Experiments were performed utilizing beryllium single crystals and polycrystalline material in an effort to produce randomly oriented wrought beryllium and to relate the deformation modes to texture development during plastic deformation. It was determined that (10$\bar{1}$2) type twinning appears to be one of the most predominant modes of deformation at temperatures as high as 1066°C. The prior texture of beryllium appeared to affect the development of preferred orientations, especially at low reductions. The mechanical properties of compression-rolled sheet approached those of upset sheet. The degree of preferred orientations developed by rolling beryllium at 1000°C was greater than that obtained by rolling at 450°C and annealing between each pass at temperatures of about 800°C. (auth)

4289 (NMI-1239) A METALLOGRAPHIC STUDY OF THE SWELLING OF URANIUM AND URANIUM ALLOYS. A. Boltax and A. R. Lumbert (Nuclear Metals, Inc., Concord, Mass.). Aug. 17, 1960. 78p. Contract AT(30-1)-1565. OTS.

The behavior of inert gases was studied in inoculated uranium and uranium alloy (U–1.6, 2.8, and 10 wt. % Mo, U–2 wt. % Zr, U–0.3 Cr–0.3 Mo, U–1 and 2 wt. % C, and U–3.8 wt. % Si) samples. Helium was injected into metal samples by α particle irradiation; krypton by glow-discharge techniques. Following gas inoculation, samples were given various isothermal and thermal cycling heat treatments to permit the formation of gas bubbles. The gas bubbles were observed in the light microscope after mechanical polishing and after chemical etching and in the electron microscope after cathodic vacuum etching. Helium gas bubbles were observed in the cyclotron-irradiated samples following various heat treatments between 475 and 1075°C. The majority of the gas bubbles in any sample, independent of heat treatment, were between 0.05 and 2 μ in diameter (10^{10} to 10^{14} per cc), and accounted for up to 10% porosity. Postirradiation heat treatments above 900°C gave rise to the formation of a small number (about 10^5 per cc) of large bubbles between 10 and 150 μ in diameter which accounted for porosities up to several hundred per cent. The large volume increase caused by the latter bubbles is similar to that observed in metallic reactor fuel elements irradiated at temperatures above 400°C. Effects of recrystallization and phase transformations on the behavior of the helium gas bubbles were noted. The nucleation and growth characteristics of the small and large bubbles are discussed. (auth)

4290 (NP-9402) RENSEIGNEMENTS STATISTIQUES SUR LA "TENUE" DU COMBUSTIBLE FOURNIS PAR L' EXPLOITATION DU REACTEUR EL_3. (Statistical Yields on the Behavior of Fuel from Operation of the EL-3 Reactor). J. A. Stohr. France. Commissariat à l'Énergie Atomique. [Centre d'Études Nucléaires], Saclay. Aug. 10, 1959. 21p.

The U-Nb and U-Mo fuel from the first loading of the EL-3 is described, and radiographic studies of them are reported. At 400 MWD/T intervals, elements were removed from the reactor and radiographed by a special apparatus, which is described. The study showed that all the molybdenum alloys used (1.5, 2, 3, and 10%) are suitable up to 450°C at a thermal flux of 220 watts/cm^2 and to a burn-up of 5000 MWD/T. No deformation was observed. A swelling study at 600°C indicated that the 1.5 and 3% molybdenum alloys are useable. (T.R.H.)

4291 (NP-9403) DETECTION DES DEFAUTS DE COULEE DES COMBUSTIBLES À BASE D'URANIUM, PAR GAMMAGRAPHIE. (Detection of Casting Defects in Uranium-base Fuels by Gammagraphy). Ch. Allain. France. Commissariat à l'Energie Atomique. [Centre d'Etudes Nucléaires, Saclay]. Aug. 6, 1959. 15p.

Vacuum casting of uranium for fuel elements leads to internal defects and inclusions; but the technique is precise and economical, so a method of nondestructive testing for these defects is necessary. Radiography is generally the most appropriate. Choice of a radiation source is difficult because of the density of uranium. Because of its high energy level (corresponding to 1400 kev), Co^{60} is preferred; but Cs^{137} would allow more sensitivity for thin sections. Conditions for exposure are discussed. Kodak Definix is the film recommended, and a negative quality indicator scale is described. The use of the technique is demonstrated on an EL-3 fuel element. (T.R.H.)

4292 (NP-9478) DEVELOPMENT OF TANTALUM–TUNGSTEN ALLOYS FOR HIGH PERFORMANCE PROPULSION SYSTEM COMPONENTS. Quarterly Report No. 5 Covering Period April 10–July 9, 1960. M. L. Torti (National Research Corp., Cambridge, Mass.). 76p. Project No. 11-1-032. Contract NOrd-18787.

Billets of tantalum–10 wt. %, 15 wt. %, and 20 wt. % tungsten were successfully extruded. The recrystallization temperature was fixed at 1600°C for the 15 and 20 wt. % tungsten alloys. Substantial room temperature ductility is observed in the annealed state for both the 15 and 20 wt. % alloys. Hot hardnesses were completed on the entire tantalum–tungsten system up to 1200°C. Little hardness increase over pure tungsten was noted for the alloys at room temperature. However, as the testing temperature was raised, the alloys containing more than 20 wt. % tungsten showed a marked hardness increase over pure tungsten. A test firing of a carburized pure tantalum nozzle at Atlantic Research failed when the carbide was penetrated. Improved analytical procedures for tungsten in tantalum were developed. High temperature testing of Ta^{90}–W^{10} sheet shows a marked increase in strength with

increasing strain rate. The effect of carbon upon the microstructure of $Ta^{90}-W^{10}$ is reported. Extensive carbide formation is noted on material containing over 100-ppm carbon. (auth)

4293 (NP-9491) STUDIES OF HEAT-RESISTANT ALLOYS. Progress Report No. 9 for March 31, 1960 to June 30, 1960. A. P. Coldren and J. W. Freeman (Michigan. Univ., Ann Arbor. Coll. of Engineering). June 30, 1960. 9p. Project No. 02760. Contract AF33(616)-5466. (UMRI-02760-10-P).

Rupture data at 1100°F and 20,000 psi for 0.06% carbon "A" Nickel are presented for the case where measurable substructures were preinduced by tensile straining at 1600°F. The maximum subboundary density was limited due to recrystallization during prestraining at 1600°F. The rupture life was increased almost three fold as the material was prestrained up to 5.37% elongation. For prestrains of 10.8 and 23.2%, the rupture life decreased to a value only slightly higher than that of non-prestrained material. Creep rate vs. substructure density data are given for low-carbon (0.01%) "A" Nickel creep tested in vacuo at 1550°F and 3,360 psi. The same type of measurements are planned for vacuum-melted carbonyl nickel to check the generality of the present results and to determine the influence of impurities on this substructure phenomenon. A procedure has been developed for rolling in an argon atmosphere, which results in carbon steel remaining bright during heating and rolling at 2100°F. It is expected that the niobium bars can be rolled without contamination. Vacuum creep-rupture testing units are being assembled and proven out for testing the niobium. (auth)

4294 (NP-9520) INVESTIGATION OF DIFFUSION BARRIERS FOR REFRACTORY METALS. Progress Report No. 4 [for] May 23, 1960 to October 15, 1960. (Manufacturing Labs., Inc., Cambridge, Mass.). Oct. 15, 1960. 37p. Project No. BSL-1958-112. Contract AF33(616)-6354.

The criteria for selection of interdiffusion barriers for each of the four refractory base metals, tungsten, tantalum, molybdenum, and niobium were reviewed. Of the 56 base-barrier combinations considered, 36 were selected for screening on the current program. In addition to four couples available from the previous program, new diffusion couples representing 23 of these combinations were prepared by pressure welding. Results of screening at 1700°C are presented for eight new combinations, as well as for further evaluation of 12 combinations studied previously. Thus far, Ta, Os, Ir, Hf, and V appear to be the most promising barrier metals for tungsten, whereas tungsten, zirconium, osmium, and iridium show the most promise for tantalum. Molybdenum and niobium-base combinations are still being evaluated. Microindentation techniques have been further refined with emphasis on improved determination of diffusion zones. (auth)

4295 (NP-9535) THE RECRYSTALLIZATION OF ZONE-REFINED ALUMINUM AS INFLUENCED BY RECOVERY AND IMPURITIES. Technical Report No. 2 and Technical Report No. 6. R. A. Vandermeer and Paul Gordon (Illinois Inst. of Tech., Chicago). Oct. 1960. 106p. Contracts AD-11-022-ORD-1984 and NONR 1406(03).

Metallographic and calorimetric studies of the recrystallization of zone-refined aluminum and alloys of this aluminum with small quantities of copper were carried out. It was found that the recrystallization is growth-controlled, nucleation being over at virtually zero annealing time. The recrystallization nuclei are colonies of grains strung along matrix grain edges; only about 5% of the matrix edges produce such colonies. Growth of the nuclei proceeds essentially in two dimensions transverse to the nucleating edges. The isothermal fraction recrystallized at early annealing periods obeys the expression $X_v = 1 - \exp(-Bt^2)$, but the rate or recrystallization tends to be retarded as annealing proceeds. This is due to a decrease in isothermal boundary migration rates with time, an effect which is the more pronounced the lower the copper content and the lower the annealing temperature for a specific copper content. Stored-energy measurements show that the decreasing growth rates result from competing recovery processes which lower the deformation energy in unrecrystallized portions of samples undergoing recrystallization. The rate of recrystallization is markedly lowered by small additions of copper, an atomic fraction of copper of 6.8×10^{-5} being enough to reduce the rate by a factor of 10^4 or more. The data obtained indicate that the equations proposed by Lücke and Detert for impurity-controlled grain-boundary migration are probably at least semiquantitatively correct in the case of copper impurities in aluminum. (auth)

4296 (ORNL-2944) METALLURGY OF ZIRCALOY-2. PART I. THE EFFECTS OF FABRICATION VARIABLES ON THE ANISOTROPY OF MECHANICAL PROPERTIES. P. L. Rittenhouse and M. L. Picklesimer (Oak Ridge National Lab., Tenn.). Nov. 15, 1960. 108p. Contract W-7405-eng-26. OTS.

The anisotropy of mechanical properties of Zircaloy-2 was studied as a function of fabrication variables. The variation in tensile and impact properties with specimen orientation was taken as the measure of the anisotropy of mechanical properties for each material. A qualitative separation of the effects of the fabrication variables on the resulting anisotropy of mechanical properties is made, but it is valid only in the rolling plane of the plate. A contractile strain ratio, a ratio of the natural contractile strain in the rolling plane to that in the direction normal to the rolling plane (measured on the round tensile specimen after testing), is introduced to aid in the interpretation of the tensile data. A Zircaloy-2 fabrication schedule (consisting of, in succession, ingot breakdown at a temperature of 1800 to 1900°F, major reduction at a temperature of 1800 to 1900 or 1350 to 1450°F, a β heat treatment of 1800 to 1850°F for 30 min, followed by either a water-quench or a rapid air-cool to below 1200°F, a final reduction of 25 to 40% at 1000°F, and an anneal at 1400 to 1425°F for 30 min) was found to produce a much more nearly isotropic material than any of the schedules investigated. This material is anisotropic in strain behavior and tensile properties in comparison to the common cubic materials. The elimination of the intermediate β heat treatment from the fabrication schedule resulted in the production of a material with tensile properties for all directions in the plane of rolling essentially the same, but which allowed little contractile strain to occur in the thickness direction of the plate. This indicated that a high degree of three-dimensional anisotropy existed in the material. The effect of cross rolling on the anisotropy of mechanical properties of Zircaloy-2 was found to be a function of the temperature and stage of fabrication at which it was performed, the position of the ingot axis relative to the final fabrication directions, and the type of cross rolling, whether unidirectional or rotational. It was concluded that the use of other methods of examination and interpretation was necessary to satisfactorily evaluate the effects of variation of the fabrication variables on the anisotropy of Zircaloy-2. (auth)

4297 (TID-6889) PAPER FOR ASM PRESENTATION STUDIES OF THE DILUTE SILICON–URANIUM ALLOY SYSTEM. W. A. Althaus (National Lead Co. of Ohio, Cincinnati). [1960?]. 12p. OTS.

In view of recent development work on the alloying of uranium metal, a study has been made of the dilute silicon–uranium alloys with varying contents of 0.05 to 0.50 wt. % silicon. The results showed the presence of two intermetallic compounds at room temperature, U_3Si and U_3Si_2, indicating that nonequilibrium conditions had taken place. Carbon in the form of uranium carbide acted as a nucleation point for these intermetallics or silicides. Silicon present over 0.25 wt. % in an alloy forms a hard, brittle, continuous phase affecting the nature of that alloy. (auth)

4298 (USBM-U-681) COMPOSITION AND MECHANICAL PROPERTIES OF SELECTED COLD-MOLD AND SKULL-CAST TITANIUM ALLOYS. E. D. Calvert, P. C. Magnusson, M. D. Carver, and R. A. Beall (Bureau of Mines. Albany Metallurgy Research Center, Ore.). July 1960. 87p.

The physical properties of titanium-base alloys in ingot and sheet form were evaluated and correlated, where possible, with variations in the melting and casting procedure. Alloying metal additions for the test alloys were 8% Mg, 6% Al plus 4% V, 6% Mo plus 2% Al, and 16% V plus 2.8% Al. The experimental procedure is described, and data on structure are included along with photographs of samples. (J.R.D.)

4299 (WADC-TR-57-649(Pt. II)) DETERMINATION OF THE MECHANICAL PROPERTIES OF AIRCRAFT-STRUCTURAL MATERIALS AT VERY HIGH TEMPERATURES AFTER RAPID HEATING. Period covered: May 1957 through June 1959. James B. Preston and J. Robert Kattus. Southern Research Inst., Birmingham, Ala. Dec. 1959. 80p. Project No. 2998. Contract AF33(616)-3494. (AD-239373).

The tensile properties of unalloyed beryllium were determined at test temperatures from ambient through 1500°F. The short-time elevated-temperature tensile properties were determined for 10 combinations of base materials and coating materials (Cr–Ni electroplate on copper sheet, Al_2O_3 on copper sheet, ZrO_2 on copper sheet, zirconium silicate on copper sheet, Cr electroplate on A-nickel sheet, Ni–Cr electroplate on molybdenum sheet, ZrO_2 on molded graphite, zirconium silicate on molded graphite, SiC on molded graphite, and SiC-SiN on molded graphite). (auth)

4300 (WADC-TR-59-470) NOTCH SENSITIVITY OF HIGH-TEMPERATURE ALLOYS. Period Covered April 1958–June 1959. Howard R. Voorhees and James W. Freeman. Michigan. Univ., Ann Arbor. Research Inst. July 15, 1959. 55p. Project No. 7360. Contract AF33 (616)-5775. (AD-237221).

Examination of results on creep-rupture of notched specimens showed notch strengthening for all alloys under proper conditions, maximum strengthening for intermediate notch acuities, and two general patterns of stress-rupture time data relative to the smooth-bar curve. Analysis of observed behavior suggests that notch strengthening requires stress redistribution by yielding and creep and that it is associated with the multiaxial stress pattern produced by the notch. Both maximum principal stress and the shear-stress invariant are hypothesized to influence rupture of notched specimens through their respective effects on crack initiation and propagation. Research on crack development during creep-rupture in notched tension bars and in biaxial plate specimens is proposed in order to verify the suggested explanation for notch behavior. (auth)

4301 (WADC-TR-59-631) EVALUATION OF MECHANICAL PROPERTIES OF FIVE MATERIALS FOR FASTENER APPLICATIONS AT 900°F AND 1200°F. Progress Report for Period February 28, 1957–September 30, 1959. Thomas C. Baumgartner, Edward F. Gowen, Jr., and Corey F. Crispell (Standard Pressed Steel Co., Jenkintown, Penna.). Oct. 1959. 230p. Project No. 1318. Contract AF33(616)-3646. (AD-236001).

The static and dynamic properties of bolts and nuts fabricated from high-strength materials were determined at 68 to 1200°F and a strength range of 130,000 to 300,000 psi. The materials of fabrication include Cr–Fe alloy, Cr steel, Cr–Mo–Ni steel, Cr–Fe–Mn–Mo–Ni–Ti alloy, and a Cr–Co–Ni–Ti alloy. (C.J.G.)

4302 (WADD-TR-60-32) BERYLLIUM RESEARCH AND DEVELOPMENT IN THE AREA OF COMPOSITE MATERIALS. Period covered: June 15, 1958 to June 14, 1959. Jacob Greenspan, Gerald A. Henrikson, and Albert R. Kaufmann. Nuclear Metals, Inc., Concord, Mass. Jan. 25, 1960. 120p. Project No. 7351. Contract AF33(616)-5912. OTS.

Ductility of some beryllium composite materials was compared with the ductility of beryllium itself. Bend ductility in sheet beryllium as a function of sample width and thickness revealed that grain orientation also played a part. Strip composites consisting of alternate strips of beryllium and aluminum or silver filler metal were investigated. Clad composites did not institute unusual changes in the composites' ductility. However, cladding appeared significant as a "fail-safe" and surface-protection medium. Beryllium may be clad by rolling or extrusion when a thin silver interlayer is present between core and cladding. Silver or aluminum coating did not change unusually the tensile strength or ductility of beryllium composites. Methods for polishing beryllium surfaces are described. (auth)

4303 (WADD-TR-60-116) BERYLLIUM CRACK PROPAGATION AND EFFECTS OF SURFACE CONDITION. [Period covered] July 1, 1958–December 31, 1959. C. O. Matthews, M. I. Jacobson, W. E. Jahsman, and W. V. Ward. Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif. Jan. 31, 1960. 196p. Project No. 7351. Contract AF33(616)-5978. OTS.

The effect of various surface finishes (as-received, ground, etched, etched and scratched, ground and shot-peened, and milled) on the properties of rolled beryllium sheet was investigated. Static tensile tests were conducted at –65 to 1200°F; and notch sensitivity, bend ductility, fatigue, and impact tests over a range of temperatures were made. Best properties were obtained on a sheet that had been etched to remove surface defects by machining. Ductility was low in all cases but was increased by heating at 400 to 600°F. The fatigue endurance limit was as high as the static tensile strength, and it was improved by etching. Impact tests were found to be most suitable for distinguishing between various surfaces. Theoretical analyses were made of the effect of including residual stress in the Griffith crack theory and of the dynamic stress at the leading edge of a crack in a uniaxially stressed plate. (C.J.G.)

4304 (WADD-TR-60-143) RESEARCH STUDY TO DETERMINE THE PHASE EQUILIBRIUM RELATIONS OF SELECTED METAL CARBIDES AT HIGH TEMPERATURES. Period covered January 1959–March 1960. R. T.

Dolloff (Union Carbide Corp. Parma Research Lab., Ohio). Mar. 31, 1960. 28p. Project No. 7350. Contract AF33 (616)-6286. OTS.

An investigation of phase equilibria in the ternary system, silicon-boron-carbon, is reported. Techniques for extending the high-temperature range of measurements were developed. Accurate phase diagrams for the silicon-carbon and the boron-carbon binaries were obtained and details of the ternary system were determined in the high carbon content region. The data were obtained by high temperature differential thermal analysis and by photoelectric thermal analysis, both supplemented by metallographic, x-ray, and chemical techniques. Results for the boron-carbon binary system indicate that boron melts at 2130 ± 10°C and that B_4C has a congruent melting point of 2470 ± 20°C. Boron and B_4C form a eutectic at 2080 ± 20°C, whereas carbon and B_4C form a eutectic at 2390 ± 20°C. Results for the silicon-carbon binary indicate a eutectic between silicon and SiC at 1402 ± 5°C. SiC melts incongruently at 2540 ± 40°C. The peritectic point is located at 27% carbon. Results for the ternary system indicate a eutectic between B_4C, SiC, and carbon at 2250 ± 20°C. No compound formation was observed in the high carbon region of the ternary system. (auth)

4305 (WAL-TR-834.21/2) TOUGHNESS OF STEEL SHEET: THE ADVANTAGE OF LAMINATING. S. V. Arnold (Watertown Arsenal Labs., Mass.). Oct. 1960. 25p. DA Project No. 5B93-32-004. (PB-171044). OTS.

Impact tests of simulated sheet prepared in various gages by machining and grinding AISI 4340 steel bar stock quenched and tempered to 210,000 and 165,000 psi tensile strength values were conducted to show the relation of impact energy to temperature, gage, and strength level. The data demonstrate a behavior pattern whereby sheet of appropriate gage and strength may be selected to assure ductile fracture in tearing under impact loads. This pattern also defines the advantages to be realized over certain temperature ranges by laminating, i.e., using two or more thinner sheets in place of a single sheet of the same aggregate thickness. (auth)

4306 (AEC-tr-4291) ANALYSIS OF THE STRUCTURE OF POWDERY SUBSTANCES USING STREAMING GASES. O. Grubner. Translated by Lydia Venters (Argonne National Lab.) from Collection of Czechoslov. Chem. Commun. 25, No. 1, 180-93(1960). 20p. JCL.

An experiment was made to confirm the applicability of the method of the stationary isothermal gas flow to analyze the internal structure of nonconsolidated, isotropic powdery media without inner porosity. The verification was carried out by comparing the structural data obtained by the flow method with those measured with other independent methods. Helium, argon, kypton, and air were the gases used for the measurements. The substances used for structure measurements were dry TiO_2, NiO, CuO, SiO_2, ZnO, MgO, and quartz pressed in tablets. To obtain a definite grain size, some of the powders were sifted through a sieve. The apparatus used in the measurements is described in detail. (W.L.H.)

4307 (CEA-tr-A-617) VARIATIONS DE STRUCTURE DES ACIERS AU CHROME-NICKEL-MOLYBDÈNE LORS DE SOLLICITATIONS DE LONGUE DURÉE. (Structural Variations in Chromium-Nickel-Molybdenum Steels During Treatments of Long Duration). F. Wever, A. Krisch, and H. J. Wiester. [Max-Planck-Institut für Physik, Gottingen]. Translated into French from Report No. 314. [195?]. 49p.

The flow and rupture behavior was verified in prolonged tests at 500°C of 5 heat-resisting Cr-Mo-Ni steels with compositions of 0.04 to 0.30% C, 0.5 to 0.9% Cr, 1.4 to 1.6% Ni, and 0.7 to 0.9% Mo. The steels were subjected to different heat treatments (quenching in air or oil with tempering at 570°C, intermediate quenching at 350 and 450°C without tempering, and quenching in oil or water with tempering at 620 to 660°C. It appears that the behavior of these steels depends on the tempering temperature and on the formation of the carbide phase, while the effect of the structure formed in $\gamma-\alpha$ transformation is of much less importance. For untempered or slightly tempered samples a precipitation of finely distributed Mo_2C was observed. (T.R.H.)

4308 (CEA-tr-A-737) FRAGILISATION DE L'ACIER DU À L'ABSORPTION D'HYDROGÈNE ATOMIQUE. (Embrittlement of Steel by Absorption of Atomic Hydrogen). O. Werner. Translated into French from VDI Zeitschrift 101, 1303-4(1959). 13p.

Damage resulting from hydrogen absorption by steel is discussed, experiments on hydrogen embrittlement are described, and a theory is offered. Hydrogen, unlike other gases, does not combine with the iron but diffuses into the structure of steel, especially at high temperature. The concentration of hydrogen in steel is about 6 cc/100g. It precipitates in the molecular state upon solidification and causes volume changes in phase transformations, resulting in pores and cracks. The experiments show that the hydrogen affects the tensile properties, structure, and damping power. The hydrogen atoms are in an ionized state and so can diffuse readily in iron. At deformed sites the hydrogen atoms concentrate enough so that molecular hydrogen forms and causes defects. (T.R.H.)

4309 (CEA-tr-I-35) RÉACTIF UNIQUE D'ATTAQUE POUR L'EXAMEN MICROGRAPHIQUE DES ACIERS INOXYDABLES FERRITIQUES, MARTENSITIQUES ET AUSTÉNITIQUES, DE LA PHASE SIGMA ET DES ACIERS RAPIDES. (Unique Etching Reagent for Micrographic Examination of the Sigma Phase of Ferritic, Martensitic, and Austenitic Stainless Steels and High-Speed Steels). G. Catella and C. Giometto. Translated into French by L. Roulet from Metallurgia ital. 49, 200-5(1957). 22p.

An etchant was developed for microstructure examination of the sigma phase of ferritic, austenitic, and martensitic stainless steels and high-speed steels. The reagent consists of 100 cc of a 1 or 2% solution of picric acid in ethanol to which is added 10 cc of HCl and 6 cc of glacial acetic acid. The usefulness and performance of the etchant is demonstrated in a series of micrographs. (T.R.H.)

4310 (CEA-tr-R-527) INFLUENCE DE L'HYDROGÈNE SUR LES PROPRIÉTÉS DE L'ALLIAGE VT-8 À LIMITE DE FLUAGE ÉLEVÉE. (Effects of Hydrogen on the Properties of VT-8 Alloy at the Upper Creep Limit). I. I. Kornilov, S. G. Glazunov (Glazounov), and A. M. Yakimova (Iakimova). Translated into French by N. Nedelko from Fiz. Metal. i Metalloved. 8, 370-7(1959). 20p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 12956.

4311 (CEA-tr-R-957) INFLUENCE DES ULTRASONS SUR LA TEXTURE DES ALLIAGES EUTECTIQUES. (Effects of Ultrasound on the Texture of Eutectic Alloys). V. V. Zaboleev-Zotov and G. I. Pogodin-Alexeev. Translated into French from Metalloved. i Obrabotka Metal. No. 1, 2-6(1958). 17p.

A detailed study is reported on Pb–Sb alloys to reveal the influence of ultrasonics on the formation of their texture. The research involved the Zn–Sn, Al–Sn, and aluminum systems as well. First the effects of alloy composition were studied at 5% intervals (at 2% near the eutectic). The ultrasound destroys the dendrites of the additive component and reduces the grains, and causes either compact and rounded grains to form (Al, Pb, Sn, and Zn) or a cubic structure (Sb). The effect of ultrasound on the texture of the additive and the effects of the ultrasound intensity were also studied. The studies indicate that it may become possible to control the crystallization of metals by means of ultrasonic waves and produce castings of definite texture and mechanical properties. (T.R.H.)

4312 (CEA-tr-R-963) DÉCARBURATION DES ACIERS DURS PAR L'HYDROGÈNE AUX TEMPÉRATURES ET PRESSIONS ÉLEVÉES. (Decarbidation of Steels by Hydrogen at High Temperatures and Pressures). S. L. Skop, V. P. Teodorovich, and V. V. Ipat'ev (Ipatiev). Translated into French from Zhur. Priklad. Khim. 31, 1894-7(1958). 11p.

A study was made of the effect of temperature, pressure, and time on the depth of decarbidation of hard steels in H_2. From experimental data an expression was found which relates length of latent period to pressure and temperature. The value of the constant in this expression coincides with values reported in the literature. An approximative empirical formula was derived for calculation of the depth of decarbidation of a plate of steel 6-mm thick for temperatures of 400 to 500°C and different pressures of hydrogen. (T.R.H.)

4313 (CEA-tr-R-980) MESURES AUX RAYONS X DES TENSIONS ÉLASTIQUES DANS LES MÉTAUX. (X-Ray Measurement of Elastic Stress in Metals). E. Schibold and Kh. Stroppe. Translated into French from Metalloved. i Obrabotka Metal. No. 10, 16-19(1959). 9p.

The x-ray method for measuring metallic deformation is described. It is based on precise measurement of the elongation or modification of the equidistances of planes in the crystalline lattice. This modification is determined by a displacement of the lines of the radiogram. Because of the proportionality between the elastic deformations and the stresses in the isotopes or quasi-isotopes, it is possible to determine both size and direction of the stress. Methods are suggested for reducing some of the operations and calculations involved. This radiographic method can be used where the mechanical method cannot. A further improvement is possible with an ionization x-ray spectrograph. (T.R.H.)

4314 (JPRS-3925) FORWARD FLOW AT THE BOUNDARY OF THE ZONE OF DEFORMATION. M. N. Potoskuyev. Translated from Izvest. Vysshikh Ucheb. Zavedenif, Chernaya Met. No. 5, 61-7(1960). 11p. OTS.

An analysis of the relation of forward flow with drawing and the gripping index at the boundary of the zone of deformation in metals is presented. (C.J.G.)

4315 (NP-tr-512) TANTALUM AND NIOBIUM. G. V. Samsonov and V. I. Konstantinov. Translated from a publication of State Publishing House of Scientific and Technical Literature on Ferrous and Non-Ferrous Metallurgy, Moscow, 1959. 359p. OTS.

The following subjects are discussed: general information on the properties and compounds of tantalum and niobium; the minerals, ores, and concentrates of tantalum and niobium; the metallurgy of the two metals; welding, mechanical working, and heat-treatment in the manufacture of tantalum and niobium products; the deposition of tantalum and niobium coatings on base materials; characteristic reactions and chemical determination of tantalum and niobium; two-component alloys of tantalum and niobium; three-component alloys; and quaternary and higher alloys containing the two metals. (W.L.H.)

4316 (UCRL-Trans-378) THE STRUCTURE OF LIQUID METALS. I. V. Radchenko. Translated from Uspekhi Fiz. Nauk 61, 249-76(1957). 89p. (includes original, 28p.). JCL or LC.

This paper was previously abstracted from the original language and appears in NSA, Vol. 11, abstract No. 7208.

4317 DIMOLYBDENUM CARBIDE. R. J. Fries and Charles P. Kempter (Los Alamos Scientific Lab., N. Mex.). Anal. Chem. 32, 1898(1960) Dec.

X-ray powder diffraction analysis was carried out at 25°C on a Mo_2C sample of purity corresponding to a stoichiometry of $Mo_{2.08}C$, and the data were used in conjunction with an IBM 704 computer to derive the lattice constants. The back-reflection lattice constants are $a_0 = 3.00281 \pm 0.00007$ A and $c_0 = 4.72878 \pm 0.00014$ A. Correcting for refraction, the following results are obtained: $a_0 = 3.00292$ A, $c_0 = 4.72895$ A, and $c_0/a_0 = 1.575$, which gives a hexagonal unit cell volume of 36.929 A^3 and a theoretical density of 9.167 g/cm^3 at 25°C. (D.L.C.)

4318 THE PLUTONIUM–ZIRCONIUM PHASE DIAGRAM. J. A. C. Marples (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). J. Less-Common Metals 2, 331-51(1960) Oct. (In English)

The entire plutonium–zirconium phase diagram was investigated from room temperature to 1300°C. The main features of the diagram are: continuous solubility between ϵ-plutonium and β-zirconium; a wide δ-plutonium phase field extending across the diagram to 70 at. % zirconium at 600°C; a maximum solubility of plutonium in α-zirconium of 13 at. % at 618°C; a depression of the α/β transformation in zirconium to a eutectoid at 618°C; a compound at about 75 at. % zirconium with an hexagonal P 6/mmm structure and with a = 5.055 A, c = 3.123 A, which on heating to 380°C decomposes peritectoidally to α-zirconium and δ-plutonium; a compound of unknown crystal structure (approx. Pu_4Zr) with a wide composition range from about 12 at. % to about 25 at. % zirconium decomposing congruently to δ-plutonium at 340°C; and solubilities in α-, β-, and γ-plutonium of approximately 1.5, 7, and 3 at. % zirconium, respectively. The δ-plutonium structure may readily be retained by quenching samples with compositions between 5 and 70 at. % zirconium, but it is not an equilibrium phase below 267°C. ϵ-Plutonium or β-zirconium cannot be retained by quenching at any composition. Possible valencies of the component metals and Brillouin zones for the α-zirconium and K phases are proposed; these enable the observed composition ranges of the two phases to be explained in terms of zone theory. (auth)

4319 THE VARIATION OF UNIT-CELL EDGE OF URANIUM MONOCARBIDE IN ARC MELTED URANIUM–CARBON ALLOYS. J. Williams, R. A. J. Sambell, and D. Wilkinson (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). J. Less-Common Metals 2, 352-6 (1960) Oct. (In English) (AERE-M-625)

The unit-cell edge of uranium monocarbide in arc-melted uranium–carbon alloys varies between 4.9600 ± 0.0005 A and 4.9520 ± 0.0002 A in a systematic manner with carbon content up to approximately 4.8 wt. %. Annealing at 1300°C

in vacuo causes all cell edges to approach the former value slowly. The compositions studied ranged from 2.5 wt. % carbon up to 7.0 wt. % carbon, but beyond approximately 4.8 wt. %, the cell edge varied little with composition. The variations in cell edge are believed to be due to structural variation in the monocarbide itself, and not to contamination with oxygen or nitrogen. (auth)

4320 THE MELTING POINT OF OSMIUM. A. G. Knapton, J. Savill, and R. Siddall (Associated Electrical Industries, Aldermaston, Berks, Eng.). J. Less-Common Metals 2, 357-9(1960) Oct. (In English)

In the literature the accepted melting point of osmium metal is reported as 2750°C. It was established that this value is low; a redetermination gives 3045 ± 30°C. (auth)

4321 SOME OBSERVATIONS ON URANIUM–MOLYBDENUM–NIOBIUM ALLOYS. G. H. Bannister and J. R. Murray (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Less-Common Metals 2, 372-82 (1960) Oct. (In English) (AERE-R-3380)

The constitution of U–Mo–Nb alloys at 1100, 1200, and 1300°C was studied, mainly by metallographic and x-ray methods; and isothermal sections were obtained. The decomposition of the body-centered cubic γ phase in alloys containing 5 at. % molybdenum and approximately 50 at. % uranium occurred very slowly at temperatures near the maximum of the miscibility gap. Additions of molybdenum were found to decrease the rate of the monotectoid reaction $\gamma_1 \rightarrow \alpha + \gamma_2$. Room temperature lattice parameters of quenched homogeneous γ alloys were obtained, and a hardness survey of the same alloys showed that a maximum occurred at approximately 50 at. % niobium and a minimum at 85 at. % uranium. The effect of molybdenum on the maximum temperature of the miscibility gap is discussed in terms of the strain energy in the solid solution from which it is formed. (auth)

4322 HARDENING OF A MOLYBDENUM ALLOY BY NITRIDE DISPERSIONS. A. K. Mukherjee and J. W. Martin (Univ. of Oxford, Eng.). J. Less-Common Metals 2, 392-8 (1960) Oct. (In English)

A highly stable dispersion of TiN was produced in molybdenum by the isothermal heat treatment in nitrogen of a 1% Ti–Mo alloy in the temperature range 1100 to 1500°C. The dispersed phase was studied metallographically, and microhardness traverses made of the diffusion layer. The hardness of the surface layers was approximately doubled, but the microhardness fell on passing inwards from the surface. The results are discussed in terms of the relation between hardness, particle sizes, and diffusion rates. (auth)

4323 GRAIN BOUNDARY MIGRATION IN NIOBIUM. W. F. Sheely (Union Carbide Metals Co., Niagara Falls, N. Y.). J. Less-Common Metals 2, 399-401(1960) Oct. (In English)

Observations of a distinctive internal structure believed to result from grain-boundary migration in niobium are reported. A 65 g button of niobium was etched to produce etch pits at the emergence point of dislocations. The regular lines of the etch pits that were formed appeared to be related to nearby grain boundaries. It was concluded that these lines of etch pits delineate periodic positions of migrating grain boundaries. (M.C.G.)

4324 THERMODYNAMICS OF THE LEAD–ANTIMONY SYSTEM. Linda Warner Diller, Raymond L. Orr, and Ralph Hultgren (Univ. of California, Berkeley). J. Phys. Chem. 64, 1736-8(1960) Nov.

Heats of formation of solid α-phase Pb–Sb alloys were measured by solution calorimetry. These data were combined with previously known data in the liquid state and the phase diagram to complete the thermodynamic description of the α phase. The thermodynamic data for both solid and liquid alloys and the phase diagram were critically evaluated and discussed, and selected thermodynamic properties were tabulated. An attempt is made to interpret the unusually large positive values found for the excess partial molar entropy of antimony in the α phase. (auth)

4325 STUDY OF MAGNETIZATION KINETICS IN IRON NEAR THE CURIE POINT BY NEUTRON SCATTER. Magda Ericson and Bernard Jacrot (Centre d'Etudes Nucléaires, Saclay, France). J. phys. radium 20, 178-9(1959) Feb. (In French) (CEA-1140)

A study was made of the kinetics of magnetization fluctuations by means of neutron scatter in iron close to the curie point. Results have confirmed the validity of Heisenberg's model in iron. (auth)

4326 BERYLLIUM OXIDE AND ITS PROPERTIES. P. P. Budnikov and R. A. Belyaev. Zhur. Priklad. Khim. 33, 1921-40(1960) Sept. (In Russian)

In view of its highly refractory character, good nuclear properties, satisfactory thermal shock resistance, and excellent chemical resistance, which make it very useful as structural material in high temperature reactors, the available information on the physical and chemical properties of BeO is reviewed. This material is also useful for the manufacture of electrical insulators and phosphors, and it serves as a raw material for the preparation of metallic beryllium and beryllium alloys. It forms hexagonal, Wurtzite type crystals. Depending on the method of preparation, the density of the material ranges from 2.20 to 2.95 g/cm^3, although it was reported that by hot-pressing the density of 3.01 g/cm^3 was reached. The melting point is given in the recent literature within the range of 2520 to 2570°C and the boiling point data range from 3900 to 4260 ± 160°C. Data on the heats of fusion, evaporation, sublimation, formation, and dissociation are reported. Also tabulated are enthalpy, temperature dependence of entropy, free energy of formation, coefficient of linear expansion, thermal shock resistance, breakage strength, modulus of elasticity as function of bulk weight, temperature dependence of heat conductivity, creep data, specific resistivity, properties of irradiated specimens, and crystalline parameters. Among the chemical properties reported are corrosive behavior, interaction with H_2O, H_2O_2, SO_2, S, Br, F, I, CS_2, $COCl_2$, CCl_4, HF, HCl, and its behavior toward Pb, Mo, Ni, Nb, Ti, Zr, Be, Si, W, ThO_2, ZrO_2, UO_2, and C at various temperatures. The phase diagrams of BeO with SiO_2, ThO_2, Al_2O_3, UO_2, ZrO_2 are also discussed briefly. The toxicological properties of BeO are reviewed. 61 references. (TTT)

4327 STRUCTURAL CHANGES AND PROPERTIES OF OXIDE LAYER FORMED ON THE SURFACE OF ALUMINUM. A. Domon and E. Likhtenberger (Research Inst. for Non-Ferrous Metals of the Hungarian Popular Republic, Budapest). Zhur. Priklad. Khim. 33, 1940-51(1960) Sept. (In Russian)

Pure hydrargillite and hydrargillite brought in close contact with aluminum powder were subjected to x-ray-diffraction analysis for the purpose of elucidating the structure of the oxide film formed on the surface of metallic aluminum at various temperatures. The results obtained indicated that the degree of hydration and structural transformations

not only depend on temperature but are strongly influenced by the migration of aluminum ions from the base metal. This explains the subsequent transformation at higher temperatures of the protective film formed below 100°C in aqueous medium under high pressure, and of the amorphous, anodically obtained layer. The oxide-hydrates, not in close contact with the metal have a different structure. Ions diffusing from the metal are responsible for the anomalously high stability of the thermodynamically less stable oxide-hydrates formed on the surface of the metal. (TTT)

4328 THE PROPERTIES OF THE RARE EARTH METALS AND COMPOUNDS. John A. Gibson, James F. Miller, Paul S. Kennedy, and George W. P. Rengstorff, comps. Battelle Memorial Inst., Columbus, Ohio. May 1, 1959. For Rare Earth Research Group. 231p. $10.00.

A compilation is given of the properties of the rare earth metals and their compounds. As a convenience, the properties of yttrium are included. The compilation is divided into four sections: (1) tabulation of the properties of elements and their compounds; (2) phase diagrams; (3) properties of elements and their compounds by the element, with reference to information source; and (4) listing of references. Most of the metallurgical properties, such as hardness, fabricability, and tensile strength, are lacking. No attempt was made to list such properties as solubilities in various media or to indicate the reactions of the rare earth compounds. 114 references. (B.O.G.)

Radiation Effects

4329 (60-RL-2388 E) PARAMAGNETIC RESONANCE STUDIES OF IRRADIATED HIGH-DENSITY POLYETHYLENE. I. RADICAL SPECIES AND THE EFFECT OF ENVIRONMENT ON THEIR BEHAVIOR. E. J. Lawton, J. S. Balwit, and R. S. Powell. General Electric Co. Research Lab., Schenectady, N. Y. Mar. 11, 1960. 29p. OTS.

Linear polyethylene was irradiated at different temperatures with 800-kv (peak) electrons. It was examined for paramagnetic resonance at +25 and −196°C to determine the radical species and their postirradiation behavior as well as that of the crystalline trapping medium. At low doses the spectrum is composed of two radical species which decay at different rates at room temperature. The predominant radical decays to zero in about 5 days; its 6-line hyperfine structure is attributed to $-\dot{C}H_2-CH-CH_2-$. The other radical has a basic 5-line spectrum with additional "very-fine" structure; it lasts for months at room temperature. The behavior of the "very-fine" structure on cooling to liquid nitrogen temperature and the initial low concentration of the radical suggest its probable structure to be $-CH_2-H_2C\cdot|\cdot CH_2-CH_2-$. The relative numbers of each radical trapped at room temperature depended on the rigidity of the crystal and, therefore, on temperature during irradiation. The relative numbers of 6-line radicals at room temperature 20 minutes after irradiation to 40 megaroentgens at −196°, +20°, and +70°C were 1.0, 0.34, 0.087, respectively; the corresponding 5-line radicals were 0.37, 0.38, and 0.30. The 6-line radical pairs existed as several groups decaying at different rates at room temperature. The number trapped at zero time was 3.3 times that of the 20-min measurement. The half-life of the fastest decaying group was 10 sec, that of the slowest, 25 hr. The fastest group comprised pairs in which the two radicals are formed nearly opposite each other on adjacent chains. They cause spin-spin line broadening in the time zero LN spectrum. It is proposed that these pairs are formed by a one-step molecular process, or a process involving a "hot" H atom, whereas the slowly decaying groups are formed by a radical process. The decay rate of the radical pair is determined by the rigidity of the crystal. An apparent transition point for the crystal was found to exist at −70°C, below which there was only a slight decay of the closest-spaced radicals. The total number of radicals produced and trapped by 40 megaroentgens at LN temperature was 6.2×10^{19}/gram, which corresponded to a G(total radicals) = 3.0. Reproducibility of the DPPH standard was better than 10% when oxygen was excluded, which had a pronounced effect on the spectrum due to strong spin-spin interaction. (auth)

4330 (AD-237172) TEMPERATURE DISTRIBUTION OF SNOW WITH GAMMA RAY RADIATION. Research Report 67. Chi Tien. Army Snow Ice and Permafrost Research Establishment, Wilmette, Ill. Jan. 1960. 8p.

The temperature distribution in snow subjected to γ radiation from an operating nuclear reactor is analyzed mathematically, assuming that the effect of radiation is equivalent to a continuous heat source the intensity of which is a function of the radial distance from the reactor. Steady-state solutions are derived for cases in which the radial distance is 13 and 19.1 ft. The results indicate that the temperature of the snow in certain regions in the several feet immediately below the foundation will exceed the design limit of 20°F. Increasing the shielding of the reactor will reduce the intensity of the radiation and the snow temperature. Other possible ways to reduce the snow temperature include the use of refrigeration coils and the forcing of atmospheric air through the snow. (auth)

4331 (AD-237469) NUCLEAR RADIATION RESISTANT POWER TRANSISTORS. Quarterly Progress Report No. 3 [for] November 15, 1959 to February 15, 1960. A. Byer (Philco Corp. Lansdale Tube Co. Div., Penna.). 24p. Contract DA-36-039-SC-78307. (R109-C).

Improvements in collector-to-header soldering eliminated BV_{CBO} degradation. The emitter pits were found to be concave in shape, thereby causing a higher resistivity at the center of the electrode than at the outer edges. The base index tab is now soldered to the base pin to serve as the electrical connection. Attempts to eliminate collector degradation with time were unsuccessful. (C.J.G.)

4332 (AD-239656) RADIATION INDUCED RESISTIVITY CHANGES IN NICKEL. Memorandum Report M60-29-1. D. B. Rosenblatt (Frankford Arsenal. Pitman-Dunn Lab., Philadelphia). Mar. 1960. 10p. DA Project Nos: 502-01-008 and 599-04-001.

The room-temperature irradiation of nickel wire revealed anomalies in the increase of the electrical resistivity. Previously reported resistivity increases were not always found and were not reproducible. The annealing of excess resistivity produced by cold work followed a smooth curve, with significant rates of disappearance of defects in the temperature range just above room temperature. The relationship between this behavior and the irreproducibility of data obtained with irradiated specimens is discussed. (C.J.G.)

4333 (AFOSR-TN-60-945) THE TRANSPORT PROPERTIES OF A FULLY IONIZED GAS. I. A QUANTAL STUDY OF DIFFUSION AND VISCOSITY CROSS SECTIONS FOR A SCREENED COULOMB POTENTIAL. Technical Report No. 5. M. R. C. McDowell and G. Peach. Georgia Inst. of Tech., Atlanta. Engineering Experiment Station. Sept. 1, 1960. 60p. Project No. A-251. Contract AF18(600)-1524.

Born's approximation and the Massey-Mohr approxima-

tion are used to obtain quantum mechanical values of the diffusion and viscosity cross sections Q_D and Q_η for a screened coulomb potential. The parameters are chosen to represent an ionized gas with $10^3 \leq n_e \leq 10^{18}$, n_e being the electron density, and $5 \times 10^3 \leq T_e \leq 10^{7}$°K, T_e being the temperature. The scattering phase shifts are also evaluated and compared with those obtained from direct numerical integration of the scattering equation. Born's approximation to the phase shift is used in a Faxén-Holtsmark type analysis to give more accurate values of the cross sections at low T and large n_e. The results are used to discuss the behavior of the electrical conductivity of a fully ionized gas. At high temperatures they are in close agreement with values derived by earlier workers, but they predict a different temperature dependence if (T/n_e) is small. (auth)

4334 (CRFD-973) CONCERNING THE EFFECTS OF EXCESS OXYGEN IN UO_2. J. A. L. Robertson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Oct. 1960. 19p. (AECL-1123). AECL.

Earlier beliefs that excess oxygen in UO_2 was undesirable for its application as a nuclear fuel have been confirmed. Nonstoichiometric material exhibits larger diametral expansion and greater release of fission-product gases than does stoichiometric UO_2 under similar conditions. The results obtained from experimental specimens were used to estimate the effects of excess oxygen on the irradiation behavior of the most highly rated fuel elements in the CANDU reactor. A maximum value for the O:U ratio of 2.01 is dictated by gas-release requirements; there is a real incentive to obtain even lower values. There is at present no simple, rapid, and reliable method for determining O:U ratios in production control. Measurement of the electrical resistivity at high temperatures may in the future be developed for this purpose. Meanwhile the streak test of mineralogy can be useful for routine control and comparisons. This test has already demonstrated that originally stoichiometric UO_2 irradiated in a "defected" sheath in water as coolant becomes oxidized. (auth)

4335 (DOFL-TR-803) EFFECTS OF SPECTRUM ON NEUTRON RADIATION DAMAGE IN SOLIDS. John S. Wicklund (Diamond Ordnance Fuze Labs., Washington, D. C.). Dec. 15, 1959. 17p. Project DA-5N98-09-003. (AD-230422).

Under certain simplifying assumptions, analytical expressions for the assessment of neutron damage in solids can be derived which take into account the neutron energy spectrum. These relations in many cases obviate the need for detailed machine calculations. The effects are treated of a variety of spectra, a method is developed for comparing spectra in terms of radiation damage, and expressions are derived for neutron damage as a function of time and neutron energy. (auth)

4336 (GEAP-3440(Rev.) FISSION GASES, THEIR MEASUREMENT AND EVALUATION. T. J. Slosek and B. Weidenbaum. General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif. Aug. 15, 1960. 17p. Contract AT(04-3)-189. OTS.

The merits and shortcomings of four techniques which may be used in fission-gas-release analyses are discussed. Results from a typical experiment are used to show the extent and type of data which can be generated by each method. Probable errors in the reported fission yield values for certain noble gas isotopes are pointed out. A standard procedure for the conduct of fission-gas-release determinations is recommended. (auth)

4337 (NAA-SR-Memo-2759) FISSION GAS PRODUCTION IN UO_2 FUEL ROD. R. A. Blaine. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. May 21, 1958. 7p. OTS.

Studies were made to determine the amount of fission gas released in 1 cc of a 3½ at. % U^{235} enriched UO_2 fuel rod after an exposure of 14,000 Mwd per ton. The gases produced as a result of fission are Br, Kr, I, Xe, and O. Equations are presented for calculating the amount of fission-gas release. (W.L.H.)

4338 (NAA-SR-Memo-5437) IRRADIATION AND TEMPERATURE HISTORY OF SRE DUMMY ELEMENT CANS. R. A. Lewis. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. June 23, 1960. 5p. OTS.

The SRE corner channel dummy elements consisted of cylindrical graphite fillers clad in zirconium. The irradiation and temperature history of the midplane of each dummy element is given with an axial irradiation factor for computations on any axial point. (W.D.M.)

4339 (NAA-SR-Memo-5556) THE EFFECTS OF NUCLEAR RADIATION ON SEMICONDUCTOR MATERIALS AND DEVICES. A. Anderman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 9, 1960. 36p. OTS.

The effects of radiation on semiconductor devices, with particular emphasis on diodes, transistors, and tunnel diodes, are reviewed. General theories of radiation damage and device operation are presented. (C.J.G.)

4340 (NARF-60-25T) DOSE RATES FROM ALLOYS IRRADIATED IN THE RADIATION EFFECTS TESTING FACILITY. A. D. King and J. H. Lewis (Convair, Fort Worth, Tex.). Nov. 11, 1960. 51p. Contract AF33(600)-38946. (MR-N-269).

Twenty-five alloys were irradiated in the Convair Radiation Effects Testing Facility for 50 hr at 200 kw as a continuation of the materials-activation program. The alloys were mounted on a rotary specimen disk in order to obtain a uniform neutron exposure for each specimen. Data are presented in the form of γ dose-rate decay curves. A spectral analysis of the γ rays from each alloy having long half life activities was made, and the dose rates due to the individual γ-ray energies in the spectra were computed. (auth)

4341 (NLCO-816) PREDICTION OF DIMENSIONAL CHANGES IN URANIUM FUEL ELEMENTS DURING IRRADIATION—THE ELASTIC SOLUTION INTERIM REPORT. Peter R. Morris and Richard N. Thudium (National Lead Co. of Ohio, Cincinnati). Sept. 22, 1960. 19p. Contract AT(30-1)-1156. OTS.

Equations were derived for the prediction of dimensional changes and stresses in thick-walled hollow cylindrical uranium fuel-element cores during thermal-neutron irradiation. The equations provide a means for combining discrete preferred-orientation data obtained from a finite series of x-ray-diffraction measurements. A comparison of calculated stresses with the creep strength of uranium should determine whether a plastic solution is necessary. (auth)

4342 (NP-9276) AN INVESTIGATION OF CREEP IN IRRADIATED POLYETHYLENE PLASTIC (thesis). John J. Powell (Naval Postgraduate School, Monterey, Calif.). 1959. 35p.

Studies were made on creep in irradiated polyethylene.

A general discussion of creep in metals and plastics is contained. (C.J.G.)

4343 (NP-9404) LA TECHNIQUE DES REPLIQUES METALLOGRAPHIQUES APPLIQUEE À L'EXAMEN DES COMBUSTIBLES IRRADIES. (The Technique of Metallographic Replicas in Examination of Irradiated Fuel). J. Laniesse, F. Poitrat, and M. L. Chamagne. France. Commissariat à l'Énergie Atomique. [Centre d'Etudes Nucléaires, Saclay]. Aug. 13, 1959. 15p. (DM/780).

Two metallographic replica techniques for irradiated fuel elements are described and evaluated. The sample preparation involved coating to a standard size with a mixture of 6 parts hardener plus 45 parts araldite D to facilitate remote manipulation, mechanical polishing, electrolytic polishing, and electrolysis in a bath of 5 ml acetic acid and 5 g oxalic acid in 100 ml distilled water. The first replica technique involves a nitrocellulose varnish, but separation is difficult. A polyvinylacetylchloride which is less adherent is better. Separation by remote control is accomplished by ultrasonics in a 2% detergent solution. For micrography, the flat replica is stuck on a glass plate and washed, dried, and metallized with aluminum. The "rhodoid" method, more recently used, consists of applying a piece of rhodoid. The opacity of the rhodoid makes metallization unnecessary. This method is of use only on plane surfaces, but is more useful when remote handling is indicated. (T.R.H.)

4344 (NP-9427) MONTHLY ACCESSION LIST 40 [ON RADIATION EFFECTS DATA]. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Oct. 15, 1960. 27p. Project No. 4458. Contract AF33(616)-7375.

Abstracts of 69 papers pertaining to radiation effects on electrical and electronic systems, polymeric materials, lubricants, hydraulic fluids, organic and inorganic chemicals, metals, and alloys are presented. Abstracts on dosimetry, irradiation facilities, and space radiation are included. (C.J.G.)

4345 (NRL-5450) EFFECT OF RADIATION UPON CERAMIC-BONDED STRAIN GAGES. N. J. Rendler and R. C. Smith (Naval Research Lab., Washington, D. C.). Apr. 20, 1960. 20p. (AD-237596).

A study of radiation effects upon ceramic-bonded strain gages indicated that strain gages must be radiation compensated in a manner analogous to temperature compensation. Electrical resistance of gage elements varied with reactor power, exhibiting both a partial recovery and a permanent damage effect. (C.J.G.)

4346 (ORO-323) THE INFRARED SPECTRA OF POLYETHYLENE BEFORE AND AFTER NUCLEAR IRRADIATION (thesis). Marion Nixon Todd, Jr. Georgia. Univ., Athens. 1960. 48p. OTS.

The effects of fast-neutron and γ radiation on the 1- to 16-$\mu\mu$ region of the polyethylene spectrum are reported. A band was found at 9.83μ which is assigned to disubstituted cyclopentanes and cyclohexanes. Ring-linking of polymer end groups was observed to take place during irradiation, accompanied by a loss of hydrogen. Studies were made on the extent of infrared absorbance as a linear function of polyethylene film thickness. (C.J.G.)

4347 (USNRDL-TR-472) EFFECT OF AMINE ADDITIVES ON COMPRESSION SET, CROSSLINKING AND CHAIN SCISSION IN AN IRRADIATED RUBBER VULCANIZATE. W. E. Shelberg, J. F. Pestaner, and L. H. Gevantman (Naval Radiological Defense Lab., San Francisco). 30p.

The effects of a wide variety of amine additives on radiation-induced compression set, crosslinking, and chain scission in a natural rubber vulcanizate irradiated in the absence of air were investigated. The compression set of an irradiated vulcanizate is changed when an additive changes the degree of initial crosslinking or acts as an effective antirad. A relation between compression set and the degree of initial crosslinking was determined, and the amine additives were evaluated as antirads with this relation being taken into account. An effective antirad plus a high degree of initial cure is the ideal combination for reducing compression set. Conversely, an effective antirad plus a low degree of initial cure is the ideal for preventing radiation damage in a noncompressed vulcanizate. N-Cyclohexyl-N'-phenyl-p-phenylenediamine, 2-aminobenzimidazole, 1,3-di-o-tolylguanidine, and acridine were found to be antirads up to a 10^5 r dose of γ radiation. Several other amines promoted, rather than hindered, compression set. Radiation yields of chain scission and crosslinking were determined by combining compression set and solvent swelling data. (auth)

4348 AN ATTEMPT TO INTERPRET CERTAIN OPTICAL ABSORPTION BANDS IN FLUORITE IRRADIATED WITH X-RAYS. Yves Allain. Compt. rend. 248, 2318-20(1959) Apr. 20. (In French) (CEA-1235)

According to the results of one experiment, the absorption band 575 mμ of fluorite irradiated with x rays seems to be due to F^--ion vacancies. A model is sought for the color centers in fluorite, colored under various conditions. (auth)

PHYSICS

General and Miscellaneous

4349 (AD-235795) INVESTIGATION OF THE REFLECTION AND SCATTERING OF MOLECULES BY SOLID SURFACES. Final Report for Period Ending March 31, 1960. Paul M. Marcus (Carnegie Inst. of Tech., Pittsburgh). Apr. 8, 1960. 20p. Project No. 019-602. Contract Nonr 760(11).

Measurements of K atom direct-beam distributions at low oven pressures were found to agree quite well with the predicted Maxwellian distributions. A deficiency of low-velocity atoms which appears at higher oven pressures was found to be caused by self-scattering of the beam in the region just outside the oven slit. Velocity distribution measurements were made on a K atom beam reflected by polished copper, gold, fused quartz, rolled tungsten strip, and cleaved surfaces of MgO and LiF crystals at 550 to 750°K. The velocity distribution was measured in the direction of specular reflection only, and the angles of incidence and reflection were 45°. A method of calculating the energy exchange between a solid surface and an impinging atom is described. (See also NP-8310.) (C.J.G.)

4350 (AD-236106) THERMOELECTRIC MATERIALS AND DEVICE RESEARCH. Second Quarterly Progress Report [for] December 18, 1959–March 17, 1960. B. R. Gossick and H. B. Whitehurst. Arizona State Univ., Tempe. 12p. Contract DA-36-039-SC-85249.

Methods for making and testing sintered pellets of polycrystalline rutile are described, along with problems en-

countered in making samples which contain dispersed metallic phases of colloidal dimensions. A device to measure thermoelectric power is described. (C.J.G.)

4351 (AD-237414) A RIGOROUS DERIVATION OF FERMI AGE THEORY (thesis). Martin A. Leibowitz (Los Alamos Scientific Lab., N. Mex.). Apr. 1960. 130p. Contract Nonr 1866(34).

Submitted to Harvard Univ.

An infinite homogeneous, nonabsorbing and isotropic moderator of 0°K is considered, containing only nuclei of a single species and such that only elastic scattering occurs with the distribution of the scattering angle in the center of mass frame being independent of the neutron energy. It is shown that as the atomic weight of the moderator tends to infinity, Fermi age theory is approached. A stochastic method is used. The probability distribution of neutron lethargy as a function of the number of collisions made and the spatial distribution of the neutron as a function of its lethargy and the number of collisions made are treated. The function $D(z|ueI_M; M)$ is introduced, which is the probability distribution of z when the neutron's lethargy lies in the interval I_M, given that the lethargy does in fact lie in I_M after at least one collision. Neutron distributions that depend on lethargy and the time from birth are discussed. (W.D.M.)

4352 (AERE-T/M-109) BEHAVIOUR OF LITHIUM TRITIDE. W. M. Lomer (Gt. Brit. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1954. 6p.

Solid metallic tritides that were proposed as target materials for nuclear reaction studies may disintegrate spontaneously when a sufficient quantity of tritium has decayed to helium. The life of a crystal of LiH is estimated to be only a few weeks. The treatment is very tentative, but seems unlikely to be grossly in error. (auth)

4353 (AFCRC-TN-60-165) HIGH TEMPERATURE THERMAL RADIATION PROPERTIES OF SOLID MATERIALS. Scientific Report No. 2. Henry H. Blau, Jr., Eleanor Chaffee, John R. Jasperse, and William S. Martin (Little (Arthur D.) Inc., Cambridge, Mass.). Mar. 31, 1960. 63p. Contract AF19(604)-2639. (AD-236394).

Thermal radiation properties of solid materials are defined, and the relations among various parameters are developed. Methods of measurement and apparatus for measuring both spectral and total radiation are discussed. The absolute intensity method was used to determine the normal spectral emittance of graphite, TaC, and SiC from 2 to 15μ in the near-infrared region. The normal spectral emittance of $MoSi_2$ at 0.65μ was measured as a function of temperature for both pure and preoxidized specimens. (C.J.G.)

4354 (AFOSR-TN-59-1336) CESIUM ION MOTOR RESEARCH. R. C. Speiser and C. R. Dulgeroff. Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif. 1959. 11p. Contracts AF49(638)-351 and AF33(616)-5927. (AD-240986).

Presented at the Second Symposium on Advanced Propulsion Concepts, Boston, October 7-8, 1959.

One of several methods of electrical propulsion involves the electrostatic acceleration of ions. Experimental studies with cesium surface ionization devices operated as miniature ion motor configurations are reported. (W.D.M.)

4355 (AFOSR-TN-60-1184) INTERRUPTION OF NUCLEAR SPIN DIFFUSION. W. H. Tanttila and D. A. Jennings. Colorado. Univ., Boulder. Oct. 1960. 12p. Contract AF49(638)-611.

Experimental results are shown in which the nuclear spin diffusion responsible for nuclear relaxation at low temperature, under certain circumstances, can be interrupted by introducing strains into crystals either by the paramagnetic impurity introduced into the crystal or by surface strains made to be significant by grinding the sample to a powder. Nuclei with large quadrupole moments, such as iodine, have their spin diffusion strongly interrupted; whereas nuclei with no quadrupole moment, such as fluorine, show no effect of strains on the spin diffusion. The interpretations are made from measured values of the spin-lattice relaxation time at liquid helium temperature. (auth)

4356 (AFSWC-TN-60-30) ATTENUATION OF STRESS WAVES IN BI-LINEAR MATERIALS. Richard Skalak (Weidlinger (Paul), New York). Oct. 1960. 24p. Project No. 1080. Contract AF29(601)-2855.

The attenuation of plane stress waves generated by a decaying surface pressure in a bi-linear medium is investigated to obtain an approximate solution to the problem of a medium with a stress-strain diagram of positive curvature. Wave equations are derived, and it is demonstrated that, beyond a given distance from the surface, the intensity of the peak stress and particle velocity depends only on a single parameter. This result is of significance in establishing the relevant physical characteristics of granular soils which are subjected to very high intensity nuclear surface blast pressures. (auth)

4357 (ANL-6214) PHYSICS DIVISION SUMMARY REPORT, SEPTEMBER, OCTOBER 1960. (Argonne National Lab., Ill.). 27p. Contract W-31-109-eng-38. OTS.

The use and operation of the Van de Graaff generator are summarized for the period from January 1 to June 30, 1960. Molecular beam study final results are given for Mn^{56}, and progress on the new atomic-beam machine is reported to date. A preliminary investigation was made of the neutron total cross section of cobalt. Results are presented. The decomposition of trichlorobromomethane by the isomeric transition of 4.4-hr Br^{80m} and β^-,γ decay of 35.9-hr Br^{82} was studied. The fragmentation patterns initiated by the two nuclear transitions differ markedly, the one caused by the isomeric transition was dominated by spectra of multiply-charged atomic species, whereas the pattern due to Br^{82} was entirely made up of singly-charged products. An investigation of nondiagonal matrix elements arising in a shell-model treatment of a deformed nucleus showed that their neglect in determining the degree of deformation does not lead to serious error. A previous statement, in a study of collective effects and the shell model, about K = 0 bands in odd-odd nuclei is corrected. The effect of residual interactions is calculated, and the result is applied to Ho^{166}. (For preceding period see ANL-6190.) (W.D.M.)

4358 (ANL-6224) THERMAL STRESSES IN CONCENTRICALLY HEATED HOLLOW CYLINDERS. Supplemental Data on Coefficient of Thermal Expansion, Modulus of Elasticity and Poisson's Ratio as Functions of Temperature. J. C. Heap. Argonne National Lab., Ill. Oct. 1960. 38p. Contract W-31-109-eng-38. OTS.

The basic theoretical equations of thermal stress for a concentrically heated hollow cylinder having the coefficient of thermal expansion as a function of temperature were developed. A table is provided for the rapid computation of the cylindrical unit stresses for which the coefficient of thermal expansion is a linear function of the temperature or independent of the temperature. Tables and graphs were

prepared for correlating the coefficient of thermal expansion, modulus of elasticity, Poisson's ratio, and product of the coefficient of thermal expansion, and modulus of elasticity at elevated temperatures by fitting curves to existing data. The stainless steels considered were 18% Cr-8% Ni–Type 304; 18% Cr-8% Ni, Ti–Type 321; 18% Cr-8% Ni, Nb–Type 347; and 25% Cr-20% Ni–Type 310. Computations for a hypothetical example were used to illustrate the difference between using the mean coefficient of thermal expansion and using the coefficient of thermal expansion as a function of temperature. (auth)

4359 (ARL-TN-60-115) ROTATING POWER GENERATION MACHINERY FOR ELECTRICAL PROPULSION. G. T. Harness. Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif. May 1960. 29p. Contract AF49(638)-649. (R-1934; AD-237791).

The generation of power for the electrical propulsion of rockets is studied. Possible propulsion power systems for control and communication at elevated temperatures are explored. Characteristics of known synchronous and asynchronous types of electromagnetic generators are summarized. Some advantages are seen in the Van de Graaff and two- and four-pole electrostatic generators. Semiconductor rectifiers and the use of vacuum tubes are considered in a discussion of lightweight transformers and rectifiers to operate at elevated temperatures. It is concluded that operation at 1000°F will be attained. However, considering such problems as bearing lubrication, possible radiation damage, radiator size, and turbine-blade requirements, new design principles and new materials are needed for operation at higher temperatures. (auth)

4360 CF-60-1-96(Rev.1)) CALCULATED THERMAL IONIZATION AND ENTHALPY OF HYDROGEN, NITROGEN, AND ARGON AT ONE ATMOSPHERE PRESSURE IN THE 298-20,000°K TEMPERATURE RANGE. W. D. Bond (Oak Ridge National Lab., Tenn.). Sept. 15, 1960. 13p. OTS.

4361 (DEG-Report-229) ESTIMATION OF SURFACE AREAS BY A GAS-CHROMATOGRAPHIC METHOD. J. F. Ellis, C. W. Forrest, and D. D. Howe (United Kingdom Atomic Energy Authority. Development and Engineering Group, Capenhurst, Ches., England). Aug. 19, 1960. 9p. BIS.

A gas-chromatographic method for measuring the surface area of powders in the range 0.005 to 14.2 m^2/g is described. The method is based on gas adsorption measurements in a continuously flowing system in which nitrogen acts as the adsorbing gas and helium as the carrier gas. (C.J.G.)

4362 (LA-2460) PROPOSED METHOD OF MEASURING THERMAL DIFFUSIVITY AT HIGH TEMPERATURES. Robert D. Cowan (Los Alamos Scientific Lab., N. Mex.). Aug. 1, 1960. 46p. Contract W-7405-eng-36. OTS.

The possibility of determining the thermal diffusivity of a thin solid plate mounted in a vacuum and heated to incandescence by means of a high-energy electron beam impinging on one face of the plate was studied. The beam energy is to be modulated by either a square wave or a sine wave and the resulting temperature-modulation of the faces observed photoelectrically. The possibility of deducing the thermal diffusivity of the solid from amplitude and/or phase measurements is investigated theoretically. The most practical method was found to be one that involves sine-wave modulation and measurement of the phase difference between the temperatures of the two faces of the plate. With plate thicknesses of about 1 mm and frequencies of the order of 0.01 to 100 cps (depending on the value of α), it should be possible to measure thermal diffusivities to within 25% at any temperature from about 1000°K to the point where sublimation becomes troublesome. (auth)

4363 (MLM-1099) ANALYSIS OF HYDROGEN ISOTOPES BY MASS SPECTROMETRY. K. W. Foster (Mound Lab., Miamisburg, Ohio). Jan. 29, 1960. 16p. Contract AT-33-1-GEN-53. OTS.

A mathematical investigation was made of the data obtained from the analysis of hydrogen isotopes by mass spectrometry. Using theoretically predicted fractionation ratios for the various molecular species, it is shown that the peak heights of mass one through mass six can be resolved into ratios for protium, deuterium, and tritium. Two methods of treating experimental data are presented, and the relative precisions are discussed. (auth)

4364 (MND-P-2316) LOADING, SHIPPING AND TESTING PROCEDURES FOR TASK 2 ISOTOPIC POWERED THERMOELECTRIC GENERATOR. Preliminary Technical Manual. M. J. Reilly. Martin Co. Nuclear Div., Baltimore. Mar. 24, 1960. 44p. Contract AT(30-3)-217. OTS.

A preliminary report on the operations and procedures for handling a 125-w thermoelectric generator and its isotopic heat source is presented. Full-scale mock-ups were used to develop the procedures. A cylindrical metal block of Inconel X will be remotely loaded with an isotope at ORNL. The block will then be sealed and loaded into a specially designed cask and shipped by rail to the Martin nuclear hot cell facility, where the second phase of the operation will be conducted. (W.D.M.)

4365 (MND-P-2366) CURIUM FUELED GENERATORS FOR LUNAR AND SPACE MISSIONS. Preliminary Safety Analysis Report. Cecil O. Riggs (Martin Co. Nuclear Div., Baltimore). June 1960. 55p. OTS.

Two thermoelectric generators that use Cm^{242} as the heat source are described. One, designed for a lunar mission, is fueled with 3.76 g of Cm^{242} with an activity of 12,480 c. The second, designed for a satellite or space probe mission, is fueled with 6.28 g having an activity of 20,400 c. Preparation of the fuel, assembly of the generator, and the launching of the vehicle are considered. Accidents that may occur in the launching of the vehicle are analyzed and the fate of the fuel in the event of an aborted mission or upon reentry of the vehicle after the completion of a mission are determined. (W.D.M.)

4366 (MND-P-3012-I) SNAP PROGRAMS. Quarterly Progress Report No. 4 for July 1 through September 30, 1960. Tasks 2 and 3. P. J. Dick, comp. and ed. (Martin Co. Nuclear Div., Baltimore). 53p. Contract AT(30-3)-217. OTS.

SNAP-1A: All ground handling equipment required to accomplish hot-cell welding of the fuel core closure seals, fuel core transportation, generator fuel core loading, and isotope generator handling was completed in manufacturing. Functional tests of this equipment to determine its conformance to prescribed ground handling procedures were initiated. Final assembly of the G-2 generator was completed and performance tests with an electrically heated source block were made. The generator was removed from the test chamber in preparation for vibration tests. Two Inconel X source containers for Ce^{144} fuel loading were machined and assembled. In addition, three practice cores for remote welding test purposes were fabricated. Dissimilar metal seals of stainless steel and aluminum for use

at six closure areas between the G-3 generator inner and outer skins were completed. A pressure-tight seal was obtained at the stainless-steel-to-aluminum interface by ultrasonic welding. Evaluation and testing of high-temperature resistance electrical insulation coatings were accomplished for possible application to the G-3 generator stainless-steel hot skin. A Bureau of Standards A-418 ceramic film formulation showed good adherence at elevated temperature and satisfactory electrical resistance at room temperature. SNAP-III: SNAP III generator, 3M-1G-10, has completed 250 days of continuous life test operation. It has been operating since January 26, 1960. Power output was 1.96 watts (e) at the end of this reporting period compared with 2.25 watts at the beginning of this quarter and 3.45 watts at the start of life tests. Preparations were made to fuel SNAP III generator 1-G-5 with 2000 curies of Po^{210}. (For preceding period see MND-P-3011.) (auth)

4367 (NAA-SR-Memo-4207) INTERPRETATION OF RESONANCE CAPTURE DATA FOR THORIUM–URANIUM FUEL ELEMENTS. A. R. Vernon (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [1960?] 7p. OTS.

The effects of U^{238} capture and uranium moderation on the effective surface to mass ratio are analyzed in an attempt to correlate resonance capture data for Th–U fuel elements. (C.J.G.)

4368 (NAA-SR-Memo-5444) DIFFUSION OF NEUTRONS IN ZIRCONIUM HYDRIDE. E. U. Vaughan. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. [1960?]. 8p. OTS.

Neutron diffusion in $ZrH_{1.6}$ is calculated in terms of the thermal utilization factor. (C.J.G.)

4369 (NAA-SR-Memo-5565) THE INFLUENCE OF SMALL CAVITIES ON THE EFFECTIVE EMISSIVITY OF A PLANE SURFACE. Ernst Treuenfels (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 4, 1960. 23p. OTS.

The influence of small cavities of various geometries on the effective thermal radiation emissivity of a plane surface was calculated and found to increase the effective emissivity of that surface. The effective emissivity was found to be greater the greater the coverage of the surface by cavities. The percentual increase was found to be greater the smaller the emissivity of the plane surface. (C.J.G.)

4370 (NAA-SR-Memo-5618) MONTE CARLO SLOWING DOWN MOMENTS. E. R. Cohen. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Sept. 2, 1960. 8p. OTS.

In the calculation of slowing down of neutrons, the azimuthal angle of scattering is an "ignorable" coordinate in the sense that it does not appear in the description of the kinematics of a collision. If one is interested only in the slowing-down moments, it is possible to average each collision over the azimuth angle and thereby reduce the number of variables. The second and fourth moments of the slowing down are calculated by recursion formulas. (W.D.M.)

4371 (NP-9390) ASTRONAUTICS INFORMATION—OPEN LITERATURE SURVEY. VOLUME II, NUMBER 9. (ENTRIES 22,671-22,870). (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Sept. 1960. 65p. Contract NASw-6.

A bibliography containing 200 abstracts is presented on various aspects of space flight, rocket propulsion systems, and astrophysics. (C.J.G.)

4372 (NP-9415) RESEARCH ON SOLID STATE RADIATION-INDUCED PHENOMENA. Quarterly Report No. 2 for May, June, and July 1960. Hartmut Kallmann (New York Univ., New York). Sept. 1960. 40p. Contract DA 36-039 SC-85126.

Quenching and Energy Transfer in Liquid Organic Solutions. Experimental data on quenchers in liquid organic solutions are given. The quenching of carbon tetrachloride, $\alpha,\alpha,\alpha,\alpha',\alpha',\alpha'$-hexachloro-p-xylene, and chloroform are compared, since it was desired to investigate the effect of quenchers of various degrees. All give linear values of the quenching factor which is in accordance with simple theory presented in previous reports. Data on the quenching effects of dilution of the transferrer are also presented. The quenching is considerably reduced by this dilution. Data on the effect of solute concentration on the amount of quenching are presented. The behavior of some of the substances is in agreement with the theory previously given but some show considerable deviations. Electrical Glow Curve Measurements of Phosphors 2150 (ZnS : Cu/Pb) and MS-17 (ZnS : Cu). Previous measurements of the photoconductivity have been extended to measurements of the conductivity during the glow, which is the heating period after preceding excitation. It has been found that the conductivity during the heating period behaves analogous to the luminescence intensity. Infrared irradiation produces effects which can be explained if one assumes that infrared does not release trapped electrons but increases the recombination probability. This explanation also holds for infrared effects on the luminescence. (auth)

4373 (NP-9431) ON THE APPLICATION OF THE THEORY OF LOCKING MEDIA TO GROUND SHOCK PHENOMENA. Includes: Sections; II. WAVE PROPAGATION IN A PLASTIC-ELASTIC MEDIUM. Richard Skalak; III. SPHERICAL WAVES IN AN IDEAL LOCKING MEDIUM. Mario G. Salvadori, Richard Skalak, and Paul Weidlinger. Weidlinger (Paul), New York. Sept. 26, 1960. 47p. For MITRE Corp. Contract AF33(600)-29852. (SR-18).

Recent investigations on ground-shock phenomena indicate that the dynamic response of certain nonlinear (locking) media may approximate the behavior of cohesive granular soils and porous rock under high pressures. There is a considerable body of fairly recent American and USSR scientific literature on this topic. It appears that the Russian investigations parallel our efforts in this field. The theory of wave propagation in such materials should have application to the design of underground shelters at very high pressure levels and may give some additional information, relatively simple means on problems associated with phenomena near ground zero in case of surface bursts or underground explosions. In Sections II and III, results of current investigations are presented. (auth)

4374 (NP-9505) FUNDAMENTOS FÍSICOS DAS EXPLOSÕES NUCLEARES E A OPERAÇÃO ARGUS. (Basic Physics of Nuclear Explosions and of the Argus Experiment). Hervasio Guimarães de Carvalho and Borisas Cimbleris (Rio de Janeiro. Centro Brasileiro de Pesquisas Físicas). [June 1959]. 20p.

A brief survey is made of the physics of nuclear explosions and the Argus experiment. The explosion mechanism of the atomic bomb and the hydrogen bomb and a historic résumé of nuclear explosions are discussed. The Argus experiment, whose aim was the study of the geomagnetic field by means of high-altitude nuclear explosions and satellites, is then described. Radiation belts around the earth and artificial auroras are considered. (J.S.R.)

4375 (NYO-7566) THE EFFECT OF EXTRANEOUS BRANCH PIPE LOADS ON THE DISTRIBUTION OF STRESS IN A PRESSURE VESSEL—NOZZLE D. Donald E. Hardenbergh and Andrew J. Edmonson (Pennsylvania State Univ., University Park). Sept. 28, 1960. 106p. Contract AT(30-1)-1874. OTS.

The effects of superimposing external loads upon the stress conditions in a pressure vessel nozzle with an internal pressure of 1 psi were studied. Results are tabulated for external loads of longitudinal and transverse bending, twisting of the branch pipe, and a thrust applied axially to the branch pipe. (C.J.G.)

4376 (NYO-9352) A SIMPLIFIED DESCRIPTION OF SPHERICAL AND CYLINDRICAL BLAST WAVES. M. P. Friedman. New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center. Aug. 1, 1960. 37p. Contracts AT(30-1)-1480 and AF49 (638)-446. OTS.

A theory is developed by which the motion of the main shock wave originating from cylindrical and spherical blasts, as well as the formation and subsequent motion of the secondary shock, are given by explicit formulas. A formulation for giving the location of the contact surface between the detonation gases and the outside atmosphere was obtained. (auth)

4377 (RADC-TN-60-51) STUDY OF COUPLED ELECTRON AND NUCLEAR SPIN SYSTEMS. National Co., Inc., Malden, Mass. Feb. 15, 1960. 26p. Project No. 8503. Contract AF30(602)-2008. (AD-238078).

A double resonance apparatus was developed for the study of the Overhauser effect in liquids containing free radicals or paramagnetic ions in solution. Within a homogeneous magnetic field, the flowing liquid is exposed first to a strong microwave field, partially saturating the electron spin resonance, and then to the r-f field of a nuclear magnetic resonance detection coil. A second nuclear magnetic resonance coil, with an independent detection and amplification system, is used for simultaneous measurements of spin-lattice relaxation times. The enhancement of the Overhauser proton magnetic polarization and the proton relaxation time, T_1, were measured for different free-radical concentrations of an aqueous solution of potassium peroxylamine disulfonate. The enhancements obtained for the different free-radical concentrations were extrapolated for total electron spin-resonance saturation conditions. A simple relation between free-radical concentration and maximum obtainable Overhauser enhancement was found. Preliminary experiments with tetrachlorosemiquinone yielded enhancements, on an average, three times higher than those obtained with potassium peroxylamine disulfonate. (auth)

4378 (SCDC-2156) STRESS-STRAIN CHARACTERISTICS OF MATERIALS AT HIGH STRAIN RATES. PART VI. THE PROPAGATION OF PLASTIC WAVES IN FINITE CYLINDERS OF STRAIN-RATE-DEPENDENT MATERIAL. Byron D. Tapley (Texas. Univ., Austin. Structural Mechanics Research Lab.). Aug. 1960. 144p. For Sandia Corp. Contract AT(29-2)-621. OTS.

The elementary theory of plastic-wave propagation as given by von Karman does not agree with some of the results obtained by experiments. In order to correctly predict the propagation of plastic waves, the strain-rate effect must be included. The elementary strain-rate theory as expressed by Malvern is in general agreement with the results obtained from experiments, but a difference in magnitude between the experimental measurements and theoretical predictions still exists. An investigation is made of the effects of the lateral inertia of the bar on the propagation of a plastic disturbance in a finite copper specimen. The actual stress-strain curve of the material is used. The linear strain-rate law is assumed, and results are obtained from both the elementary Malvern theory and a theory including the effects of radial motion. Results are also obtained from each theory by applying both a "step" in velocity and a "finite" rise in velocity to one end of the bar. These results are compared with each other and with experimental measurements. (auth)

4379 (SCR-93) LARGE EXPLODING WIRES—CORRELATION TO SMALL WIRES AND PAUSE TIME VERSUS LENGTH DEPENDENCY. E. C. Cnare and F. W. Neilson. Sandia Corp., Albuquerque, N. Mex. May 1959. 17p. OTS.

Presented at Conference on Exploding Wires, Boston, Mass., April 1959.

The results of small exploding-wire studies were found to be capable of direct extrapolation to larger wires (an increase in cross-sectional area of 1500 to 2500 from the small wires). Copper wires up to 40 mils in diameter and iron wires to 62 mils in diameter were studied for use as fuses, in lengths up to 18 in. A dependency between pause time (the time between system current cut-off and current restrike) and wire length is described for several sizes of copper wires exploded with 16.5- and 49.5-kilojoule sources. The role of wire confinement is discussed in connection with establishment of the pause. (auth)

4380 (TID-6573) EXPERIMENTAL DETERMINATION OF STRESSES IN A SPHERICAL SHELL WITH ATTACHED PIPE. R. L. Maxwell and R. W. Holland (Tennessee. Univ., Knoxville. Engineering Experiment Station). Apr. 1959. 93p. For [Oak Ridge National Lab.] Contract W-7405-eng-26, Subcontract No. 875. OTS.

An investigation was made to determine experimentally the stresses produced in a spherical shell by internal pressure and by various types of loads applied to a pipe (nipple) attached to the shell. Stress patterns were determined for the following four types of loadings: a normal load applied collinear with the nipple; a transverse load applied normal to the nipple; a pure bending moment applied to the nipple; and an internal pressure applied to the shell. The model was made of aluminum and was cast in the form of a sector of a sphere with the nipple as an integral part of the shell. (W.L.H.)

4381 (UCRL-5968) AN IN VACUO ELECTROMAGNETIC DISPERSION EXPERIMENT. S. D. Softky and R. K. Squire (California. Univ., Livermore. Lawrence Radiation Lab.). May 17, 1960. 22p. Contract W-7405-eng-48. OTS.

An experiment is proposed and analyzed which can provide a precise comparison of the in vacuo velocities of photons of widely differing energies. The suggestion is made that there may be an as yet undetected dispersion. The experimental technique employs a nuclear explosion to generate a short pulse of broad-band electromagnetic radiation and requires the measurement of the differences of flight times of photons of different frequencies over a long base line in interplanetary space. The experimental details covered are emplacement, signal strengths, background sources, communication, and instrumentation. The method can readily be employed to make velocity comparisons to a precision of ±30 m/sec. With greater sophistication and increased cost, an ultimate precision of ±10 cm/sec can be attained. (auth)

4382 (UCRL-9180) NEW FACILITIES AND AUTOMATIC TRACK ANALYSIS EQUIPMENT AT THE LAWRENCE RADIATION LABORATORY. Walter H. Barkas. California. Univ., Berkeley. Lawrence Radiation Lab. June 1960. 19p. Contract W-7405-eng-48. OTS.

Results obtained by the use of the automatic coordinate readout equipment were very satisfying. Reaction energies and masses of three kinds of hyperons were measured with good accuracy. Seven reaction and decay processes which can be analyzed by range measurements were studied. The results are described. Special equipment with automatic readout was developed and is being used for neutron spectroscopy. A Koristka MS2 microscope has been rebuilt to take large plates and automatic sagitta readout has been built in. This permits calculation of second, third, or higher differences, and elimination of the noise by any two-cell-length or difference-product method merely by using the appropriate IBM-650 program. One in use calculates the scattering sagitta for which second differences exceeding four times the resultant mean have been eliminated. Improved equipment for obtaining gap-length distributions has been built. The gaps are automatically tabulated in 10 intervals of length, and the speed of the stage is continuously variable as required by the track lacunarity. New facilities have been built for processing 20 liters of emulsion at one time so as to obtain high uniformity of development throughout the emulsion stack. A new emulsion storage facility and miscellaneous improvements in technique are discussed. (auth)

4383 (UCRL-9181) THE THEORY OF EMULSION TRACK STRUCTURE. Walter H. Barkas. California. Univ., Berkeley. Lawrence Radiation Lab. June 1960. 46p. Contract W-7405-eng-48. OTS.

The statistical geometry of a medium consisting of a matrix of one material in which are embedded spheres of another material is treated. The spheres have an arbitrary distribution of diameters and are randomly located. The elementary track cell is the distance projected on a particle trajectory between centers of spheres successively traversed by the particle. Its distribution function is found rigorously. The fluctuations of various quantities can then be treated. Corrections to old formulas that suppose the medium to consist of spheres all of the same size are made. The problem of the primary grain density in an emulsion track contains several new elements that are treated. It is necessary to establish what constitutes the effective rate of energy loss of a particle that brings about grain developability. The statistical character of the energy transfer to electrons of the crystal is formulated. In the absence of detailed knowledge of how a grain is rendered developable, dimensionality and scale arguments are introduced. Two characteristic lengths, a and b, which measure the attenuation of the grain sensitivity from the surface inward and the effect of remoteness of the point of energy transfer from a sensitivity center, are introduced. The developability cross section of a crystal is then expressible in terms of the effective energy loss rate. This leads to an expression for the primary grain density involving developability coefficients that depend only on the emulsion type when development has progressed to completion. In general, the grain may grow in development, and some grains partially occult others. The variable optical resolution of the microscope-observer system is also a complication. The gap-length coefficient of O'Caellaigh is studied, and it is proved to be identical with the true grain density, g. It is also proved that if the properly defined mean grain diameter, α, is introduced, then the density of gaps exceeding length l is B exp(–gl), where the blob density B is equal to $ge^{-g\alpha}$. The maximum gap density is equal to $(\alpha e)^{-1}$ and the lacunarity is equal to $\exp(-g\alpha)$. The secondary grain density, which is unimportant in insensitive emulsions, is found to be extremely important in sensitive fine-grained emulsions. A measurement of g gives the sum of the primary and secondary grain densities. Using the empirical connection between grain density and restricted energy loss, the primary and secondary densities are separated. The secondary grain density then is found to vary in the expected manner with particle velocity. The statistical behavior of the measured track quantities, gap density, gap length coefficient, and lacunarity is then studied. It is found that at low velocities the lacunarity provides the best measure of g and at high velocities the gap length coefficient. The transformations which give the expectation values of track quantities on inclined tracks are found. (auth)

4384 (UCRL-9277) A MASS-SPECTROMETRIC INVESTIGATION OF SULFUR VAPOR AS A FUNCTION OF TEMPERATURE (thesis). M. Charles Zietz. California. Univ., Berkeley. Lawrence Radiation Lab. June 15, 1960. Contract W-7405-eng-48. OTS.

A mass-spectrometric investigation was performed on sulfur vapor in equilibrium with the condensed phase at 120 to 210°C. It was found that, in this temperature range, equilibrium sulfur vapor contains appreciable quantities of S_8, S_7, S_6, and S_5 only. The sulfur vapor emanated as a small well-collimated molecular beam from a specially constructed source into an ionization chamber which was designed to exclude from analysis any sulfur vapor that had impinged on the walls or the hot electron filament. Essential identical ionization potentials were determined for S_8, S_7, S_6, and S_5 of 9.8 ± 0.4 ev. The heat of vaporization of S_7 was calculated to be approximately 2.5 kcal greater than that of S_8. Upper limits for S_8 and S_7 composition in S vapor at 120°C were determined to be 86% and 14%, respectively. It is proposed that S_8 is the vaporizing species, that S_7, S_6, and S_5 result from dissociation of S_8, and that all four molecules have a ring configuration. (auth)

4385 (UCRL-9364) GRAPHS AND TABLES OF ZERO-FIELD HYPERFINE-STRUCTURE LEVEL ORDERING IN FREE ATOMS. Forrest S. Baker. California. Univ., Berkeley. Lawrence Radiation Lab. Aug. 15, 1960. 147p. Contract W-7405-eng-48. OTS.

A digital computer was used to obtain solutions to the equation expressing the zero-field hyperfine-structure energy levels in free atoms as a function of the ratio of the magnetic-dipole and electric-quadrupole coefficients. Graphs and tables are given showing these level orderings and the "critical" values at which the ordering changes. (auth)

4386 (UCRL-9390) ELECTRON TRIPLET PRODUCTION BY HIGH-ENERGY PHOTONS IN HYDROGEN (thesis). Duane Charles Gates (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1, 1960. 115p. Contract W-7405-eng-48. OTS.

A 323-Mev bremsstrahlung beam was used to produce electron pairs and triplets in a 4-in.-diameter liquid hydrogen bubble chamber. The Compton electron background in the chamber was reduced by the use of 1.36 radiation lengths of LiH in the beam path. The photon flux was monitored with a Cornell type thick-wall ionization chamber. Of the 24,000 events photographed, 5417 triplets and 4019 pairs were analyzed. The ratio of apparent triplets to apparent

pairs was 0.291 ± 0.0097. The apparent triplet cross section (detectable recoils) rose logarithmically with photon energy to 100 Mev, then leveled off. The total triplet cross section agreed with that of Borsellino, and the positron energy distribution agreed with that of Wheeler and Lamb. The recoil momentum distribution agreed substantially with that of Suh and Bethe; however, their result is slightly too large in the region of large recoil momenta. The recoil angular distribution was measured. Recoils with momenta greater than 1 Mev/c predominated on the small-angle side of a peak at 50°. No events due to multiple pair production were found. (auth)

4387 (USNRDL-TR-462) THERMAL CONDUCTIVITY MEASUREMENTS ON BISMUTH TELLURIDE IN THE PRESENCE OF A 2 MEV ELECTRON BEAM. W. J. Parker and R. J. Jenkins. Naval Radiological Defense Lab., San Francisco. Sept. 2, 1960. 38p.

A procedure is described for making thermal diffusivity measurements of semiconducting materials in the presence of a 2-Mev electron beam. The beam enters the upper surface of a specimen 1 mm or less in thickness held in an insulating support while a strong horizontal flow of air passes across the upper surface to prevent the material from melting. A high-intensity short-duration light pulse is absorbed in the same surface, and the resulting temperature history of the lower surface is measured by a thermocouple and recorded with an oscilloscope and camera. The thermal diffusivity is determined by the shape of the temperature-vs.-time curve and by the heat-transfer coefficient between the upper surface and the cooling air. The thermal conductivity is equal to the product of the thermal diffusivity, the density, and the heat capacity. The product of the last two quantities was determined by the maximum temperature rise at the rear surface of a specimen whose front face was coated with camphor black and irradiated with the high intensity light flash in the absence of the electron beam and cooling air. The thermal diffusivity of bismuth telluride was determined for both n and p types, and its independence of the electron bombardment with incident currents up to 15 μa/sq cm is demonstrated. If it is assumed that the specific heat is unaffected by the electron beam, the thermal conductivity is also unaffected. (auth)

4388 (WADC-TR-59-341) A SURVEY OF HIGH PRESSURE EFFECTS OF SOLIDS. Period Covered: January 1957 to May 1959. K. L. De Vries, G. S. Baker, and P. Gibbs (Utah. Univ., Salt Lake City). Oct. 1960. 485p. Project No. 7021. Contract AF33(616)-5016. OTS.

A summary is presented of all "known" high-pressure work done on solids since 1947, with selected reference to work on liquids and gases. The data are presented in the form of 40 tables and more than 500 figures. Some 250 references are summarized. Descriptions are given on apparatus, procedure, and results. (auth)

4389 (WAPD-TM-200) ECESS—AN IBM-704 PROGRAM COMPUTING TRANSPORT EQUATION COEFFICIENTS FOR A MONATOMIC GAS MODERATOR IN THE THERMAL ENERGY REGION. W. S. Clendenin and G. R. Culpepper. Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh. Apr. 1960. 37p. Contract AT-11-1-GEN-14. OTS.

The ECESS code calculates transport equation coefficients for the thermal energy monatomic gas model of a physical moderator. The parameters of the model are the ratio (M/m) of atomic mass to neutron mass and the temperature t. Coefficients for these parameters are obtained through the P_3 approximation. In addition the code calculates infinite medium spectra of the scalar flux. The scalar flux and neutron current spectra in large geometry may also be obtained, and based on these, constants for a one-group treatment of thermal neutrons are computed. (auth)

4390 (AEC-tr-4306) ON THE PROBLEM OF THE MECHANISM OF THE DISCHARGE IN A HOLLOW CATHODE. V. A. Gromov. Translated from Optika i Spektroskopiya 1, 334-7(1956). 5p. JCL or LC.

The contribution of electron photoemission from a hollow cathode under the influence of short-wave ultraviolet emitted by the discharge on the discharge current is estimated. Various polyatomic gases (benzene, methane, CCl_4, and alcohols) were introduced to the carrier gas to absorb the short-wave ultraviolet in a manner similar to that of "quenching" gases in particle counters. (C.J.G.)

4391 (AEC-tr-4309) THEORY OF GAS PERMEABILITY OF PLASTIC FOILS. N. Buchner. Translated by Lydia Venters (Argonne National Lab.) from Kunststoffe 49, 401-6(1959). 18p. JCL.

Results of an investigation which supports the theory that gas permeates plastic foil material by the process of solution diffusion are discussed. To prove that the gas permeability of all plastic foils follow a single theory, all theoretical statements which could describe this phenomenon are examined. Results and conclusions are included. (J.R.D.)

4392 (CEA-tr-A-729) MOUVEMENT DES PARTICULES CHARGÉES DANS UN CHAMP MAGNÉTIQUE FAIBLEMENT VARIABLE. (Movement of Charged Particles in a Slightly Variable Magnetic Field). G. Hellwig. Translated into French by R. Pfeiffer from Z. Naturforsch. 10a, 508-16(1955). 29p.

The Alfven approximation equations for a slightly variable magnetic field were obtained in a manner which makes it unnecessary to distinguish between the two cases: grad H perpendicular or parallel to $\vec{H}$. This also allows a generalization in the case of relativity of an extension to higher-order approximations. It is shown that the variation as a function of time of M (magnetic moment created by spiral motion of the particle) disappears also as a second approximation with the rotational mechanical forces. The objection of Schluter to the Fermi theory concerning the post-acceleration of cosmic particles is discussed. (T.R.H.)

4393 (CEA-tr-A-808) EMISSION DE LUMIÈRE PAR LES SUBSTANCES SCINTILLANTES AVEC DES RETARDS VOISINS DE LA MICROSECONDE. (Emission of Light by Scintillating Materials with Delays Near A Microsecond). K. Einfeld. Translated into French from Z. Naturforsch. 14a, 966-71(1959). 19p.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 5747.

4394 (NP-tr-503) THE MEASUREMENT OF MAGNETO-MOTIVE FORCE (MEASUREMENT OF THE LINE MAGNETIC FIELD STRENGTH). W. Rogowski and W. Steinhaus. Translated for U.K.A.E.A. Atomic Energy Research Establishment from Arch. Elektrotech. 1, 141-50 (1912). 22p. JCL.

Theory and practice for use in estimating the line integrals of magnetic field strengths are reviewed. It is noted that by using a magnetomotive force meter, absolute and accurate magnetic measurements can be made on the Epstein apparatus and on magnetic circuits such as yokes and free coils. (J.R.D.)

4395 (SCL-T-153) EXPERIMENTS WITH HEAVY SURGE-CURRENTS. (Versuche mit Grossen Stoss-Strömen). R. Foitzik. Translated by M. I. Weinreich (Sandia Corp.) from Elektrotech. Z. 60, 89-92(1939). 15p. JCL.

A discussion is presented of the development of a high-capacity surge installation with which it is possible to generate, in the laboratory, currents equal to the greatest current intensities occurring in lightning. Measurement of such surge currents with the cathode-ray oscillograph also is discussed; and various electrodynamic, thermic, and thermodynamic effects of heavy surge currents are compared with the phenomena found in natural lightning. (J.R.D.)

4396 (UCRL-Trans-556(L)) ADVANCES OF PHYSICAL SCIENCES. PHOTO EFFECT IN METALS. S. V. Vonsovskiĭ (Vonsovsky), A. V. Sokolov, and A. Z. Veksler. Translated from Uspekhi Fiz. Nauk 56, 477-530(1955). 102p. (includes original, 54p.). JCL or LC.

A study of the interaction between electromagnetic fields and matter was conducted. A review of results is presented which includes several concrete types of interaction, such as the so-called external photoelectric effect in metallic bodies. (J.R.D.)

4397 (UCRL-Trans-601) THE STUDY OF CAUSES FOR NON-COALESCENCE OF LIQUID DROPS UNDER STATIC CONDITIONS (UNDER LENGTHY CONTACT). (Issledovanie Prichin Nesliyaniya Zhidkikh Kapel v Staticheskikh Usloviyakh (Pri Dlitel'nom Kontakte)). B. V. Deryagin (Deriagin) and P. S. Prokhorov. Translated by D. A. Nimidoff from Novye Idei v Oblasti Izucheniya Aerozoleĭ, Akad. Nauk S.S.S.R., Inst. Fiz. Khim., Sbornik Statei 84-101(1949). EXPLANATION OF THE MECHANISM OF NON-COALESCENCE OF WATER DROPS DURING COLLISION. (Vyyasnenie Mekhanizma Nesliyaniya Vodnykh Kapel Pri Soudarenii). P. S. Prokhorov. Ibid., 102-7 (1949). 35p. JCL or LC.

A study of causes for noncoalescence of liquid drops under static conditions was made. Measurements made of the gap profile between touching drops revealed that size and profile of the air gap, formed between two drops during contact, remains unchanged for an indeterminate length of time. A mechanism is proposed for the formation of excess pressure in the gap between drops which states that vapors of the liquid that diffuse from the gap attract outside air. The size of the gap between the drops was found to depend on the elasticity of the liquid vapors growing with it and from the degree of saturation surrounding the drop medium. (C.J.G.)

4398 TOTAL SCATTERING POWER OF PERTURBED LATTICES AND DISSYMMETRY OF REFLECTIONS. CASE OF ISOLATED DEFECTS. Max Tournarie. Compt. rend. 248, 987-9(1959) Feb. 16. (In French) (CEA-1151)

A study of the total scattering power (elastic and inelastic) of a perturbed lattice by displacement shows up a dissymmetric diffusion around each center increasing with the order of reflection, a general continuous background, and a central diffusion which does not result from the defect itself. (auth)

4399 TOTAL DIFFUSING POWER OF PERTURBED LATTICES AND DISSYMMETRY OF REFLECTIONS. CASE OF GROUPS OF DEFECTS. Max Tournarie. Compt. rend. 248, 2103-5(1959) Apr. 6. (In French) (CEA-1208)

The total diffusing power for a crystallite of any form containing a centrosymmetrical defect was established. The antisymmetrical part of the deformation potential only contributes very slightly to the primary dissymmetry. The case of a group of defects of the same type is then studied. The calculation converges sufficiently to describe the thermal agitation of an infinite crystal. (auth)

4400 NEUTRON RESPONSE OF SILVER-ACTIVATED PHOSPHATE GLASS. Sohei Kondo (Oak Ridge National Lab., Tenn. and National Inst. of Genetics, Misima, Japan). Health Phys. 4, 21-4(1960) Oct.

The fluorescent response of silver-activated phosphate glass rods exposed to thermal and 14 Mev neutrons was investigated. For thermal neutrons, most of the absorbed dose in the glass rods arises from β-emission of activated silver nuclei; and the response per rad in the glass rods is the same as for Co^{60} γ rays. For 14 Mev neutrons, the response per rad is 20% of that for Co^{60} γ rays. The possibility of using such dosimeters for simultaneous measurements of neutron and γ-ray intensities is discussed briefly. (auth)

4401 THE DISTRIBUTION OF MINOR IONS IN ELECTROSTATIC EQUILIBRIUM IN THE HIGH ATMOSPHERE. P. Mange (U. S. Naval Research Lab., Washington, D. C.). J. Geophys. Research 65, 2833-4(1960) Nov.

The distribution of atmospheric ions in electrostatic equilibrium with electrons is treated for an atmosphere with more than one ionic species present. The distributions of H^+ and O^+ ions are calculated for a 1500°K atmosphere, constant g, and concentrations of 10^3 and 10^5 cm^{-3} for H^+ and O^+ ions at 200-km altitude, respectively. It is concluded that light ions in the presence of a predominant heavy ion will increase with altitude, that the scale height of the predominant ion (light or heavy) approximates twice that of the corresponding neutral constituent, and that at levels where the heavy ion is a minor constituent its scale height approximates that of the corresponding neutral particle. (D.L.C.)

4402 HYDROMAGNETIC WAVES IN THE IONOSPHERE. W. E. Francis and Robert Karplus (Lockheed Aircraft Corp., Palo Alto, Calif.). J. Geophys. Research 65, 3593-3600(1960) Nov.

A numerical integration of the hydromagnetic wave equations in the ionosphere was carried out. Tables and graphs are given for the relations between the field amplitudes above and below the ionosphere and for the power dissipated as a function of altitude. The case of a vertically incident plane monochromatic wave near 45° geomagnetic latitude is treated. The results are used to confirm earlier estimates of ionospheric heating by hydromagnetic waves and to estimate the transit time of extremely low frequency signals. (auth)

4403 ELECTRON DENSITIES IN THE F REGION OF THE IONOSPHERE FROM ROCKET MEASUREMENTS. PART 1. METHODS OF ANALYSIS. John S. Nisbet and S. A. Bowhill (Pennsylvania State Univ., University Park). J. Geophys. Research 65, 3601-7(1960) Nov.

A method is described for analyzing dispersion records from long-range missiles in terms of equivalent electron-density and electron-content profiles above a fixed location. This method takes account of varying horizontal gradients in electron density and the varying local zenith angle of the ray path as a function of range time and height in the ionosphere. Refraction was considered for both Faraday rotation and range-error measurements, and correction factors are included in the program. Comparisons made between Faraday rotation and range-error measurements

and between Faraday rotation measurements at two locations demonstrated the validity of the reduction techniques. (auth)

4404 ELECTRON DENSITIES IN THE F REGION OF THE IONOSPHERE FROM ROCKET MEASUREMENTS. PART 2. RESULTS OF ANALYSIS. John S. Nisbet and S. A. Bowhill (Pennsylvania State Univ., University Park). J. Geophys. Research 65, 3609-14(1960) Nov.

Electron-density distributions in the ionosphere derived from propagation measurements made during seven long-range missile flights are given. These results are compared with measurements derived from variable-frequency pulse soundings and with satellite and rocket measurements described by others. The vertical electron-density gradient was found to vary within quite a large range, being lowest for two firings that took place shortly after sunset and greatest for the one early-morning firing. The equilibrium electron-density variation with height was found to be consistent with the assumption of a Chapman layer of varying scale height, based on a recent model of the neutral atmosphere derived from satellite retardation measurements. (auth)

4405 AN IMPROVED TECHNIQUE FOR OBTAINING ATMOSPHERIC ION MOBILITY DISTRIBUTIONS. Elden C. Whipple, Jr. (U. S. Naval Research Lab., Washington, D. C. and George Washington Univ., Washington, D. C.). J. Geophys. Research 65, 3679-84(1960) Nov.

An improved technique for obtaining atmospheric ion mobility distributions using Blackwood's double-electrode condenser is described which simplifies both the experimental procedure and the data analysis. Only the current to the second electrode needs to be measured, and it is shown that the mobility distribution can be obtained with one rather than two differentiations of the characteristic curve. Two representative small-ion distributions with good resolution, obtained with this technique, are presented and discussed. (auth)

4406 THE GYROMAGNETIC RATIO OF THE PROTON. J. H. Nelson (U. S. Coast and Geodetic Survey, Washington, D. C.). J. Geophys. Research 65, 3826(1960) Nov.

The International Association of Geomagnetism and Aeronomy recommends that all measurements of the geomagnetic field with a proton free-precession magnetometer, using pure water as a proton sample, shall be based on the value of the gyromagnetic ratio 2.67513×10^4 radians/gauss-second. (D.L.C.)

4407 THEORETICAL AND EXPERIMENTAL STUDY OF TRANSITIONS INVOLVING SEVERAL QUANTA BETWEEN THE ZEEMAN SUB-LEVELS OF AN ATOM. J. M. Winter (Centre d'Etudes Nucléaires, Saclay, France). J. phys. radium 19, 802-5(1958) Nov. (In French) (CEA-1139)

Transitions induced by a magnetic oscillating field H_1 were studied in the following hypotheses: H_1 is a rotating field perpendicular to H_0, a transition is obtained whenever $E_m - E_{m'} = \hbar\omega(m - m')$, $m - m' = 0, \pm1, \pm2 \ldots$; H_1 is elliptical. In the case of a two-level system ($J - \frac{1}{2}$) resonances are observed whenever $E_{\frac{1}{2}} - E_{-\frac{1}{2}} = p\hbar\omega$ (p any integer); and two oscillating-fields are present ($J = \frac{1}{2}$). There is resonance when $E_{\frac{1}{2}} - E_{-\frac{1}{2}} = \hbar(p\omega + q\omega')$, p, q positive or negative integers. In each case energy displacements, line widths, and line intensities were computed as a function of H_1. All the above predictions were observed experimentally. (auth)

4408 ON THE FERROMAGNETIC RESONANCE OF EUROPIUM IRON GARNET. W. P. Wolf (Clarendon Lab., Oxford, Eng.). J. Phys. Soc. Japan 15, 2104(1960) Nov. (In English)

The observed magnitude of ferromagnetic resonance in polycrystalline europium iron garnet and its variation with temperature are accounted for according to theory. (M.C.G.)

4409 OPTICAL PROPERTIES OF IRRADIATED LiF CRYSTALS IN THE EXTREME ULTRAVIOLET REGION. Riso Kato, Shin-ichi Nakashima, Kaizo Nakamura, and Yoichi Uchida (Kyoto Univ.). J. Phys. Soc. Japan 15, 2111-12(1960) Nov. (In English)

Optical absorptions of LiF single crystals irradiated with β or γ rays were measured in the extreme ultraviolet region. One specimen was found to have an absorption band at 11.1 ev, well-separated from the fundamental band, which seemed to be proportional to the F band. In two other specimens, a composite shoulder was observed that seemed to consist of at least two bands at 11.75 and 11.1 ev. (M.C.G.)

4410 N BANDS IN ALKALI HALIDE CRYSTALS. Sadao Hattori (Aichi Gakugei Univ., Nagoya, Japan). J. Phys. Soc. Japan 15, 2117-18(1960) Nov. (In English)

The N bands of some alkali halide crystals were investigated. The samples of NaCl, KBr, KI, and LiF were colored by irradiation with x rays at room temperature. Then they were bleached with their respective F light at room temperature to develop the N_1 and N_2 bands. For NaCl the bands were further investigated. Results indicated that the N_1 and N_2 bands are due to different centers. (M.C.G.)

4411 SIMILARITY METHODS IN RADIATION HYDRODYNAMICS. L. A. Elliott (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Proc. Roy. Soc. (London) A258, 287-301(1960) Oct. 25.

The extent to which problems in radiation hydrodynamics may be tackled by similarity methods was investigated for the case of spherical symmetry. In particular the problem of an intense explosion was considered. By the introduction of radiative heat flux the singularity in a solution by Taylor (1950) was removed. (auth)

4412 ON A NEW METHOD FOR INTRODUCING NATURAL C^{14} IN A LIQUID SCINTILLATOR. G. Leger, G. Delibrias, L. Pichat, and C. Baret (Centre d'Etudes Nucléaires, Saclay, France). p.261-7 of "Liquid Scintillation Counting." New York, Pergamon Press, 1958. (CEA-1075)

Liquid scintillation counting provides one of the most accurate methods of radiocarbon dating. In this method a suitable compound prepared from the sample to be dated is introduced in a liquid scintillator. A high detection efficiency for the C^{14} β-radiation is thus realized. The carbon may be introduced either as the solvent component of the liquid scintillator or as a diluent. In the latter case one must introduce sufficient quantities without severely quenching the scintillator. Futhermore, in any case, in order to introduce the maximum quantity of the carbon of the original sample it is best to choose a compound in which all the carbon atoms originate from the sample. Several workers have already worked along this line and the techniques used differ from each other by the choice of the synthesized component, the liquid scintillator, and the electronic device associated with the photomultiplier. Some of the results published up to now and an abstract of the techniques involved are given. (auth)

4413 THE PHYSICS OF FLOW THROUGH POROUS MEDIA. Revised Edition. Adrian E. Scheidegger. New York, The MacMillan Company, 1960. 329p. $15.50.

A thorough search of world literature on hydrodynamics in porous media was made and the information summarized. Past and present physical theories of flow through porous media are discussed together with a derivation of Darcy's law, a critical evaluation of the Kozeny theory, and a presentation of statistical flow theories. Displacement by both immiscible and miscible liquids is considered, and methods are outlined for solving problems of turbulent flow, molecular flow, and flow with adsorption. A large bibliography is included. (D.L.C.)

Cosmic Radiation

4414 (NP-9411) X-RAYS FROM VAN ALLEN BELT ELECTRONS. J. B. Cladis and A. J. Dessler. Lockheed Aircraft Corp. Missiles and Space Div., Palo Alto, Calif. Oct. 6, 1960. 22p.

The x-ray spectrum due to atmospheric absorption of Van Allen radiation belt electrons is calculated, based on the assumption that small-angle atmospheric scattering is the dominant loss mechanism for these electrons. It is concluded that, although the x-ray flux is highly variable, at peak intensity it should be detectable above the cosmic radiation background at balloon altitudes. A detailed series of balloon measurements of the x-ray flux at several locations around the earth, including the Capetown region, could provide quantitative data on the rate at which electrons are lost from the radiation belt and, therefore, information on the Van Allen electron source strength. Such measurements would provide an experimental test to differentiate between the neutron decay origin and the local acceleration origin for the Van Allen belt electrons. Furthermore, it should be possible from such observations to make a definitive statement as to whether the primary loss of outer zone electrons occurs through atmospheric scattering or through rapid "dumping" during geomagnetic storms. Specific balloon experiments are suggested. (auth)

4415 BALLOON OBSERVATIONS OF X RAYS IN THE AURORAL ZONE. [PART] II. K. A. Anderson and D. C. Enemark (State Univ. of Iowa, Iowa City). J. Geophys. Research 65, 3521-38(1960) Nov.

Data from a long-duration balloon flight at 35-km height over the auroral zone during August 1959 showed that only very small fluxes of energetic x rays accompany visible auroras at this latitude. The maximum observed photon flux above 25 kev during a bright aurora was 2.5 cm^{-2} sec^{-1}. Much larger fluxes, up to 40 cm^{-2} sec^{-1}, preceded two active visible displays by about 30 min. On August 17 and 18 x-ray influxes were observed for several hours during the daytime. From Explorer VI data these are believed to be associated with the filling-up of the outer radiation belt after a geomagnetic storm. The scintillation counter employed permitted a determination of the x-ray energy spectrum at 6 $g\text{-}cm^2$ depth from 25 to 300 kev on this and several other flights. From an analysis the parent electron spectrum is derived and found to be extremely steep. Typically, the ratio of the differential photon intensity at 30 kev to that at 160 kev is 350 to 1. Other balloon flights during August 1959 show that a large loss of electrons having energy >25 kev is occurring even on magnetically rather quiet days. (auth)

4416 THE COSMIC-RAY EQUATOR AND THE EARTH'S MAGNETIC FIELD. Martin A. Pomerantz (Franklin Inst., Swarthmore, Penna.), Vasant R. Potnis, and Arne E. Sandström. J. Geophys. Research 65, 3539-43(1960) Nov.

The positions of the cosmic-ray intensity minimum off the west coast of Africa and in the Indian Ocean, respectively, were determined from measurements obtained with a shipboard neutron monitor during two voyages between Scandinavia and Australia. The cosmic-ray equator is in accordance with the prediction based upon calculations of modified cutoff rigidities at the first location, but differs by 4° at the second. Contemporary observations of zero magnetic dip indicate that the cosmic-ray intensity minimum coincides with the dip equator at 14°W, but differs in geographic latitude by 2° in the vicinity of 60°E. (auth)

4417 THE SECULAR VARIATION AND THE GEOMAGNETIC THEORY OF COSMIC RADIATION. Ruth Gall (Universidad, Mexico City and Instituto Nacional de la Investigación Científica, Mexico City). J. Geophys. Research 65, 3545-58(1960) Nov.

The effect of the secular variation of the geomagnetic field on the elements of the eccentric dipole and eccentric dipole-quadripole models is discussed. The migration during the period between 1845 and 1955 of geomagnetically equivalent points and the conditions for the invariance of the differential equation of motion of charged particles in the geomagnetic field are studied. Formulas and practical rules are given for adapting calculations of cones, cutoff momenta and energies, and directions of incidence, valid for any arbitrary year, to any specific year of observation. Time corrections for the curves of cutoff momenta vs. geomagnetic latitude were calculated for the period 1845 to 1955 for points of observation distributed over the southern and northern hemispheres. (auth)

4418 THE INTERACTION OF THE TERRESTRIAL MAGNETIC FIELD WITH THE SOLAR CORPUSCULAR RADIATION. David B. Beard (Lockheed Missiles and Space Div., Sunnyvale, Calif. and Univ. of California, Davis). J. Geophys. Research 65, 3559-68(1960) Nov.

The terrestrial magnetic dipole field is assumed to exist in an intense stream of protons and electrons emanating from the sun which behaves as a diamagnetic medium terminating the earth's magnetic field at about 7 earth radii on the daylight side and up to perhaps 100 earth radii on the night side of the earth. By detailed examination of particle trajectories, the interaction between plasma and magnetic field is shown to occur within a negligibly thin current sheath enveloping the earth. Numerical solutions of the differential equation for the sheath surface reveal an approximately spherical surface on the daylight side giving rise to a more complicated expanding surface on the night side, including a prominent bump of reversed current sheath near the magnetic poles. (auth)

4419 RADIATION FROM PROTONS OF AURORAL ENERGY IN THE VICINITY OF THE EARTH. W. B. Murcray and J. H. Pope (Univ. of Alaska, College). J. Geophys. Research 65, 3569-74(1960) Nov.

Some considerations regarding the way in which auroral protons might be expected to radiate as they approach the earth are discussed. The form of the frequency-time curves which might result at the earth's surface from the radiation by such particles are deduced by assuming a reasonable model of the upper ionosphere. It is concluded, at least so far as the frequency-time curves are concerned, that auroral protons are capable of producing the low-frequency electromagnetic phenomenon known as "Chorus." (auth)

4420 ATTEMPT TO MEASURE THE COSMIC BACKGROUND RADIATION AT HIGH ALTITUDE. Jacques Labeyrie (Centre d'Etudes Nucléaires, Saclay, France) and Henri Le Boiteux. J. phys. radium 20, 573-4(1959) May. (CEA-1240)

Results are given of the measurement by Geiger-Mueller tubes of the hard component of cosmic background 0 and 60 km of altitude, at 43°N latitude, on January 27, 1959, (17 hr GMT). The counting rate starts at 0.3 pulse per second (sea level) reaches a maximum value of 15.6 (18 km), and remains constant at 5.7 above 40 km. (auth)

4421 PROCEEDINGS OF THE MOSCOW COSMIC RAY CONFERENCE, JULY 6-11, 1959. VOLUMES I, II, III, AND IV. G. B. Zhdanov and I. P. Ivanenko, eds. Moscow, International Union of Pure and Applied Physics, 1960. 1285p.

A collection of papers based on the proceedings of the International Cosmic Ray Conference held in Moscow July 6 to 11, 1959, is presented. In the six plenary and eight section meetings, one hundred reports were delivered on nuclear interactions at 10^{11} to 10^{14} ev, extensive air showers, radiation belts and primary cosmic radiation, and cosmic ray intensity variations. The more important discussions that took place at the plenary and section meetings are included. (W.D.M.)

4422 PROCEEDINGS OF THE MOSCOW COSMIC RAY CONFERENCE, JULY 6-11, 1959. VOLUME I. NUCLEAR INTERACTIONS AT ENERGIES FROM 10^{11} TO 10^{14} EV. N. M. Gerasimova and A. I. Nikishov, eds. Moscow, International Union of Pure and Applied Physics, 1960. 333p.

Fifty-two papers are contained on nuclear interactions at energies from 10^{11} to 10^{14} ev. Separate abstracts were prepared for 38 of the 52 papers. (W.D.M.)

4423 SPECTRUM OF γ-RAY AND NUCLEAR-ACTIVE COMPONENT OF AIR-SHOWERS AT 11,000 METERS. PART I. J. Duthie, C. M. Fisher, P. H. Fowler, A. Kaddoura, D. H. Perkins, and K. Pinkau (Univ. of Bristol, Eng.). p.30-4 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Two emulsion stacks were exposed at 11 km in high-flying aircraft. For particles at vertical incidence, the stacks presented a depth of 31 radiation lengths or 1.3 nuclear interaction lengths. Electromagnetic cascades (600) were observed as black lines in the emulsion sheets. Energy threshold for detection of cascades was around 1000 Bev. Track density was determined photometrically. Results suggest that, at extremely high energies, the primary nucleons dissipate progressively less energy into the soft component, at least in the early collisions, and thus that the conventional picture of the nucleonic cascade may need drastic revision. (W.D.M.)

4424 SPECTRUM OF γ-RAYS AND NUCLEAR-ACTIVE COMPONENT OF AIR-SHOWERS AT 11,000 METERS. PART II. J. Duthie, C. Fisher, P. H. Fowler, A. Kaddoura, D. H. Perkins, and K. Pinkau (Univ. of Bristol, Eng.). p.35-40 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

In part I, evidence was presented which strongly suggests that in nuclear collisions in air both the amount of energy transformed into π^0-mesons and their number are nearly independent of primary energy. Additional evidence is presented which gives information on the partition of energy among π^0-mesons in three disintegrations of 10^{15} ev that occurred outside the stack, so that the individual high-energy γ rays were well separated and individual energy estimates could be performed. (W.D.M.)

4425 ANALYSIS OF ANGULAR DISTRIBUTION OF THIN TRACKS OF SHOWERS PRODUCED BY PARTICLES WITH ENERGIES $>10^{11}$ EV. Zh. S. Takibaev (Takibayev), A. A. Loctionov, L. A. San'ko, and Ts. I. Shakhova. p.56-66 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Angular distribution of thin tracks of showers produced by cosmic particles with energies $\geq 10^{11}$ ev in the stratosphere was investigated. The characteristics of showers in the energy ranges of 10^{11} to 10^{12} ev and $E > 10^{12}$ ev are compared with various theoretical representations. To explain a number of peculiarities of the angular distribution it is recommended to take into account the role of the particles produced in the formation of an additional number of particles in secondary collisions within the target nucleus. The angular distribution of shower particles produced by multi-charge particles is also analyzed. A case of 15 + 515 Z produced by a silicon nucleus with an energy of about 600 Bev per nucleon is described. (auth)

4426 INVESTIGATION OF ENERGY SPECTRUM OF PARTICLES PRODUCED IN HIGH-ENERGY NUCLEAR INTERACTIONS. A. Kh. Vinitskiĭ (Vinitsky), I. G. Golyak, Zh. S. Takibaev (Takibayev), I. Ya. Chasnikov. p.67-76 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Showers are discussed in which the energy of the produced particles was determined by measuring multiple Coulomb scattering or, in rare cases, by measuring the relative scattering of adjacent particles. In the case of two showers the spectrum of γ-quanta resulting from the decay of π^0-mesons was obtained, the γ-quanta energy being determined on the basis of the analysis of the electron-positron pairs produced by them. The experimental data thus obtained are compared with the spectrum of γ-quanta resulting from different versions of the theory of multiple meson production. (auth)

4427 INTERACTION OF HIGH-ENERGY NUCLEONS WITH COMPLEX NUCLEI. T. P. Lazareva and P. A. Usik (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). p.77-81 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Proceeding from a conception of the interaction of a high-energy nucleon with a complex nucleus, the expected integral distribution of stars in a photographic emulsion was calculated from the number of shower particles. (W.D.M.)

4428 ESTIMATION OF THE ENERGY ($E > S \times 10^{15}$ ev) OF PRIMARY PARTICLES BY THE ANGULAR AND ENERGY DISTRIBUTION OF SECONDARY SHOWER PARTICLES. E. G. Boos and Zh. S. Takibaev (J. S. Takibayev). (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). p.82-94 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

By means of a method based on the use of the transverse momentum of shower particles, an estimation is made of the Lorentz factor $\gamma_{\bar{\varepsilon}'}$, the mean energy $\bar{\varepsilon}'$, of the generated particles and the part of the energy K transferred to these

particles. The correlation between the values k, $\bar{\epsilon}'$, n , and γ_c is studied within the framework of this method. In assessing the value of γ the energy spectrum of the shower-generating component is taken into account. It is shown that in all theories and models discussed, referring to multiple meson generation in which the primary nucleons are not separated from the emitting centers, the nature of the dependence between K and γ_c does not correspond to that observed in experiment. (auth)

4429 ON THE MULTIPLE PRODUCTION OF PARTICLES IN THE INTERACTION OF NUCLEONS OF ENERGY 10^{10}–10^{13} ev WITH EMULSION NUCLEI. A. P. Zhdanov, I. M. Kuks, N. V. Skirda, and R. M. Yakovlev (Radium Inst., Leningrad). p. 95-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Preliminary results are presented from an investigation to determine the nature of the interaction of high energy particles (10^{10} to 10^{13} ev) with atomic nuclei. On the basis of available information, an attempt was made to obtain more complete information about the mechanism of multiple production of particles by studying the distribution of shower particles over polar and azimuthal angles. (W.D.M.)

4430 NUCLEON-NUCLEON COLLISIONS OF ENERGIES BETWEEN 10 AND 100 GEV. S. Kaneko, O. Kusumoto, S. Matsumoto, and M. Takahata (Osaka City Univ.). p.107-12 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Nine nuclear interactions of primary nucleons with energies between 10 and 300 Bev, which can be explained in terms of nucleon-nucleon collisions, were analyzed. The energy and angular distributions of the secondary particles in the center-of-mass system were obtained. The energy spectrum of inverse square type agrees well with experiment except for the low energy end. The angular distribution appears to be essentially isotropic. (auth)

4431 ANGULAR DISTRIBUTIONS OF SECONDARY PARTICLES AT NUCLEAR INTERACTIONS WITH HEAVY NUCLEI OF EMULSIONS. Jen Phyong Soo, G. B. Zhdanov, and M. I. Tret'yakova. p.118-20 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Angular distributions were studied in several high energy interactions of primary particles with $z = 0$, $z = 1$, and $z > 1$. To compare angular distributions of secondary particles with the predictions of modern hydrodynamical theory, eleven jets produced by neutral or singly charged particles were selected for study. (W.D.M.)

4432 CONSEQUENCES OF THE TWO-CENTERS MODEL OF PARTICLE EMISSION IN COSMIC RAY JETS. J. Pernegr (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). p.121-6 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

It has been shown recently that the angular distribution of secondaries in high-energy cosmic ray jets might be described on the basis of a simple "two-center model" of particle emission. In these preliminary remarks, several possibilities to obtain independent proofs of the validity of this model are pointed out. (auth)

4433 ASYMMETRIES IN THE ANGULAR DISTRIBUTION OF JET PARTICLES. J. Pernegr, V. Pettžílka, and V. Šimák (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). p.127-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Azimuthal asymmetry in the distribution of secondary jet particles has been proposed as a logical consequence of a two-center mechanism of particle emission. An experimental investigation of this effect is discussed. (auth)

4434 METHODS, PROPOSED BY MOSCOW UNIVERSITY, OF STUDYING THE ELEMENTARY ACT OF INTERACTION OF NUCLEAR-ACTIVE PARTICLES OF ENERGY 10^{11}–10^{14} EV WITH ATOMIC NUCLEI. N. L. Grigorov, N. A. Kondrat'ev (Kondratiev), A. I. Savel'eva (Savelieva), V. A. Sobinyakov, A. V. Podgurskaya, and V. Ya. Shestoperov. p. 130-5 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Methods for determining the energy of primary cosmic particles in the range 10^{11} to 10^{14} ev are discussed. Operation of apparatus (ionization calorimeters) for measuring primary energies are reviewed. (W.D.M.)

4435 ANALYSIS OF JETS FROM CARBON. W. B. Fretter and L. F. Hansen (Univ. of California, Berkeley). p.136-42 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

An experiment is described which was designed to eliminate the difficulties inherent in nuclear emulsion work in that the identity of the target nucleus and the energy particles can be determined. A block of carbon 45 cm thick was placed above a cloud chamber. The cloud chamber was in a field of about 8000 gauss. Forty-one events were detected which contained three or more nuclear particles. (W.D.M.)

4436 STUDIES OF NUCLEON-NUCLEON INTERACTIONS AT ENERGIES OF 2×10^{11} EV. N. L. Grigorov, V. V. Guseva, N. A. Dobrotin, K. A. Kotelnikov, V. S. Murzin, S. V. Ryabikov, and S. A. Slavatinskiĭ (Slavatinsky). p.143-53 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

An experimental arrangement for making direct determinations of the energy of primary particles in N-N collisions at 100 to 500 Bev is described. Detailed characteristics of 16 cases of N-N interactions were obtained. A considerable portion of the showers obtained possessed pronounced nonsymmetricity. (W.D.M.)

4437 ON ONE PARTICULARITY OF INTERACTIONS OF PARTICLES WITH AN AVERAGE ENERGY OF 200 BEV. N. G. Birger, S. A. Slavatinskiĭ (Slavatinsky), and Yu. A. Smorodin (Lebedev Inst. of Physics, [Moscow]). p.154-6 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

The kinematic method of analysis is applied to the interactions of particles with an energy of 200 Bev. The method is described and applied to multiple meson production in LiH. (W.D.M.)

4438 ON THE DETERMINATION OF THE ENERGY OF FAST PARTICLES FROM ANGULAR DISTRIBUTION OF THE INTERACTION PRODUCTS. A. I. Nikishov, I. L. Rozental, and S. A. Slavatinskiĭ (Slavatinsky). p.157-60 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

For the determination of the energy of fast particles a method is used which is based on an analysis of the angular distribution of secondary particles and the simplest relationships of relativistic kinematics. The method is based on two assumptions: the velocities of the secondary particles are close to that of light, and the divergence of particles in the center-of-mass system occurs symmetrically with respect to the plane perpendicular to the line of motion. Substantiation of these two nontrivial assumptions is discussed. (W.D.M.)

4439 PERIPHERAL COLLISIONS. S. A. Slavatinskiĭ (Slavatinsky) and D. S. Chernavskiĭ (Chernavsky). p.161-9 of the "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

The theory of peripheral collisions and the interpretation of interactions at 200 Bev on the basis of peripheral collision theory are considered. (W.D.M.)

4440 A STUDY OF THE INTERACTION OF $10^{11}-10^{12}$ EV PARTICLES WITH IRON AND GRAPHITE NUCLEI. C. P. Babayan, N. L. Grigorov, M. M. Dubrovin, L. G. Mishchenko, V. S. Murzin, L. I. Sarycheva, V. A. Sobiniakov, and I. D. Rapoport. p.174-81 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

An experimental arrangement consisting of 184 pulse ionization chambers, a hodoscope, and a large Wilson chamber was used in a study of $10^{11}-10^{12}$ ev particle interactions with iron and graphite. The ionization chambers were connected to form 122 independent ionization detectors permitting the ionization to be measured within a range of 25 to 10,000 relativistic particles. Results are presented. (W.D.M.)

4441 STUDIES OF THE NATURE AND SPECTRA OF PARTICLES GENERATED BY HIGH-ENERGY NUCLEONS. A. I. Alikhanov, A. V. Khrimyan, V. K. Kosmachevskiĭ (Kosmachevsky), V. V. Avakyan, Yu. V. Gorodkov, K. Sh. Egiyan, and N. A. Nalbandyan. p.182-7 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 10354.

4442 PRODUCTION OF UNSTABLE PARTICLES IN NUCLEAR HIGH-ENERGY INTERACTIONS AND THEIR ROLE IN THE NUCLEAR CASCADE PROCESS. V. F. Vishnevskiĭ (Vishnevsky) (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). p.188-96 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

In nuclear showers unstable nuclear-active particles are created whose decay length in air is much smaller than their interaction length. In dense substances the decay length is much longer than the interaction length and therefore all the decaying particles should interact with nuclei. The absorption coefficients of unstable particles in air and in water were measured. (W.D.M.)

4443 INVESTIGATION OF THE FORMATION OF THE SOFT COMPONENT USING CERENKOV [CHERENKOV] COUNTERS. S. A. Azimov and T. S. Yuldashbaev. p.197-201 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Investigation of the relation between the energy transferred to the soft component and the energy of the primary particles is very useful in understanding the mechanism of the formation of electron-nuclear showers. The ratio of the density of the electron component to the energy of the primary particles was measured using Cherenkov counters and found to be constant for an energy increase of the primary particles from 20 to 100 Bev. (W.D.M.)

4444 ON THE ABSORPTION OF HIGH-ENERGY NUCLEAR-ACTIVE PARTICLES IN AIR AND IN A DENSE ABSORBER. S. A. Azimov, Yu. P. Kratenko, L. S. Khavin, A. A. Yuldashev, and R. Karimov (Inst. of Physics and Tech., Tashkent). p.202-6 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

To determine whether the absorption coefficient in water was affected by the density transition effect, the absorption of particles in water was measured down to depths of 10 to 11 m with the aid of three apparatuses. In one apparatus the electron-nuclear showers were selected according to penetrating particles by means of counters; in another, according to the electron-photon component by means of ionization chambers; and in the third the nonequilibrium soft component was isolated by means of a counter telescope. (W.D.M.)

4445 MORE ACCURATE DEFINITION OF THE HYDRODYNAMICAL THEORY OF MULTIPLE PARTICLE PRODUCTION. G. A. Milechin (Lebedev Inst. of Physics, [Moscow]). p.209-15 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

A more accurate definition of the hydrodynamical theory of multiple particle production is made and a generalization of the theory for the case of a nucleon-nucleus collision is given. The investigation deals only with the case when the ratio of the tunnel length of the nuclear matter cut out from the nucleus by an incident nucleon to the nucleon dimensions does not exceed 3.7. (W.D.M.)

4446 ON THE EFFECT OF VISCOSITY ON ENERGY DISTRIBUTION OF SECONDARY PARTICLES IN THE PROCESS OF MULTIPLE PRODUCTION. A. A. Emel' yanov (Yemelyanov) and D. S. Chernavskiĭ (Chernavsky) (Lebedev Inst. of Physics, [Moscow]). p.216-19 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 5825.

4447 ANALYSIS OF POSSIBLE HYDRODYNAMICAL THEORIES OF MULTIPLE PARTICLE PRODUCTION WITH DIFFERENT EQUATIONS OF STATE. G. A. Milekhin (Lebedev Inst. of Physics, [Moscow]). p.220-5 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Various theories of multiple particle production can differ either by an equation of state at the hydrodynamical approach, or by a Lagrangian at the field approach. An analysis of hydrodynamical theories with different equations of state is given. It is shown that the results obtained for a certain class of Lagrangians with a definite approximation are the same as in the hydrodynamical theory with a corresponding equation of state. (W.D.M.)

4448 A NON LOCAL FIELD THEORY OF HIGH ENERGY JETS. G. Wataghin (Università, Turin). p.231-3

of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Application of a nonlocal field theory with nonlinear interactions to the description of a high energy collision is outlined. The theory makes use of the mathematical formalism of the S-matrix and satisfies the claim of relativistic invariance and of macroscopic causality. (W.D.M.)

4449 COMPARISON BETWEEN HYDRODYNAMICAL MODEL AND FIRE BALL MODEL IN MULTIPLE PRODUCTION OF PARTICLES. S. Ishida (Kyoto Univ.), C. Iso, and M. Sato. p.244-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Two characteristic results of the two-center model are considered: the longitudinal component of the momenta of mesons must be of the same order as the transverse momenta; and the F-plot is such that each branch of lines has a slope of 2. The hydrodynamical model and two-center model are compared with respect to these characteristic results. It is shown that the hydrodynamical model can reproduce qualitative features of the two-center model for the longitudinal momentum spectra, although there are quantitative discrepancies which may be resolved by accurate experiments. (W.D.M.)

4450 INTERPRETATION OF COSMIC RAY JETS AS COMPOSITE COLLISIONS: THE TWO-CENTERS MODEL. Kurt Sitte and Ladislav Katz (Israel Inst. of Tech., Haifa). p.249-53 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Arguments previously reported in support of a composite-collision picture of cosmic ray jets are extended to describe the events in the language of the two-centers model. From general kinematic considerations, expressions are derived to calculate the number of participating nucleons as well as their energies before and after the collision. In suitable cases, these results can also be checked by a purely phenomenological analysis of the forward and backward cones. Results from a number of jets observed by the Polish-Czech emulsion group demonstrate the general tendency in jets of large n_s and large N_h of dividing unequally into forward and backward cones, with the backward particles outnumbering the others by a factor of about 2. It is pointed out that in high-energy jets a third, smaller center may occur, formed by energetic secondaries emitted at an early stage of the expansion of the meson cloud before its separation into two individually emitting systems. (auth)

4451 ASYMMETRY EFFECTS AND VARIOUS MODELS OF HIGH ENERGY NUCLEAR COLLISIONS. S. Hayakawa (Kyoto Univ., Japan), Z. Koba, and S. Takagi. p.271-3 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Classical models and descriptions are employed in a treatment of high energy nuclear collisions. The validity of quantum-mechanical considerations is assumed and quantities which can be inferred from observations are examined. (W.D.M.)

4452 IMPACT PARAMETER AND PERTURBATION TREATMENT OF THE DISTANT COLLISION OF NUCLEONS WITH PION EMISSION. H. Ezawa (Tokyo Univ.), O. Kamei, K. Mori, H. Shimoida, and T. Yoneyama. p.274-84 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

It is shown that the impact parameter is related to the angular distribution of mesons and that the impact parameter can be calculated from the experimentally observable quantities. The single meson production process is examined by perturbation methods. In the tentative calculation with the neutral pseudoscalar meson, it is found that the pseudoscalar coupling with nucleons yields satisfactory results. (W.D.M.)

4453 A MODEL FOR MULTIPLE MESON PRODUCTION WITH FINITE $N-\pi$ AND $\pi-\pi$ INTERACTION. E. G. Bubelev. p.285-91 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

A model for multiple production of mesons resulting from intensive interaction of the mesonic field of colliding nucleons is described. The assumption regarding the finiteness of such interaction permits an interpretation of the two-center jets observed at energies above 10^{12} ev and one-center jets observed at about 10^{11} ev. (W.D.M.)

4454 IMPLICATIONS OF THE HIGH ENERGY MESON SPECTRUM AND PLUS-MINUS RATIO. J. Pine, R. J. Davisson, and K. Greisen (Cornell Univ., Ithaca, N. Y.). p.295-300 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

A magnetic spectrometer was used to measure the momentum spectrum and positive excess of cosmic muons in the vertical direction near sea level. For energies up to 30 Bev, the magnetic deflections were measured with trays of geiger counters. From 15 Bev upwards, the deflections were measured with three shallow-cloud chambers expanded vertically. The maximum measurable momentum was 175 Bev/c. By comparison of the sea-level momentum spectrum with the range distribution of mesons underground, it is possible to check the theoretical expressions for the rate of energy loss of high-energy mesons in passing through matter. (W.D.M.)

4455 THE SYDNEY COSMIC RAY SPECTROMETER. H. S. Murdoch, K. W. Ogilvie, and H. D. Rathgeber (Univ. of Sydney). p.304-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

The Sydney cosmic ray spectrometer which was designed to give absolute rates and to allow measurements of the momenta of two or three particles passing through it at one time is described. The first results obtained with the instrument, installed in a tunnel under 7000 gm/cm^2 of rock, are reported. The absorber is expected to eliminate all particles except muons and their secondaries, so that a comparison of the results with the sea-level muon spectrum will allow a check to be made of energy loss calculations. (W.D.M.)

4456 ON HIGH ENERGY μ-MESON SHOWERS. A. A. Emel'yanov (Yemelyanov) and I. L. Rosental (Lebedev Inst. of Physics, [Moscow]). p.310-16 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Calculations of the lateral distribution of high-energy μ-mesons based on hydrodynamical theory are discussed. It is assumed that charged muons and nucleons have equal energy characteristics and that one-third of the pions are neutral. (W.D.M.)

4457 POLARIZATION OF COSMIC RADIATION μ-MESONS. A. I. Alikhanyan. p.317-19 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

It has been established that cosmic muons are partly polarized. Measurement of muon polarization can be used as a method to determine the form of the pion spectrum and to estimate the frequency of K-meson generation in high-energy collisions. Results of an investigation on the polarization of cosmic muons are outlined. (W.D.M.)

4458 THE POLARIZATION OF COSMIC RAY MUONS. C. S. Johnson. p.320-3 of "Proceedings of the Moscow Cosmic Ray Conferences, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

An improved measurement was made of the degree of polarization of positive muons arriving vertically at sea level. The momentum band studied was 540 to 593 Mev/c. Polarization data were obtained for iron, copper, and sulfur absorbers. (W.D.M.)

4459 HIGH-ENERGY μ-MESONS. I. S. Alexeev (Alexeyev) and G. T. Zatsepin. p.324-6 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

The generation of high-energy μ-mesons can be described by: $\pi-\mu$ decay, K-μ decay, and hypothetical direct generation of μ-mesons in nuclear collisions. The energy spectrum of μ-mesons is a major factor in ascertaining the role of the above processes. It can be calculated by solving a diffusion equation, provided the probabilities of the elementary processes making up the losses of muon energy as well as the curve of muon absorption in the ground are known. Various energy loss processes are analyzed. (W.D.M.)

4460 THE SCATTERING OF μ-MESONS IN VARIOUS SUBSTANCE. A. I. Alikhanyan. p.327-30 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume I. Nuclear Interactions at Energies from 10^{11} to 10^{14} ev."

Confirmation of the existence of anomalous scattering of μ-mesons is of fundamental significance for the theory of elementary particles. The results of an experimental investigation of muon scattering in various substances are given in brief. (W.D.M.)

4461 PROCEEDINGS OF THE MOSCOW COSMIC RAY CONFERENCE, JULY 6-11, 1959. VOLUME II. EXTENSIVE AIR SHOWERS AND CASCADES PROCESS. V. I. Zatsepin and B. A. Khrenov, eds. Moscow, International Union of Pure Applied Physics, 1960. 332p.

Included are fifty-five papers concerned with the experimental and theoretical aspects of extensive air showers, electromagnetic cascade processes, and miscellaneous items on detectors and detection methods. Of the 55 papers included, 50 were abstracted separately; abstracts of the remaining five appeared previously in NSA. (B.O.G.)

4462 GENERAL DESCRIPTION OF AN INSTALLATION FOR INVESTIGATION OF EXTENSIVE AIR SHOWERS AND PRELIMINARY RESULTS OBTAINED FROM ITS OPERATION. S. N. Vernov, G. B. Khristiansen, A. T. Abrosimov, N. N. Goryunov, V. A. Dmitriev, G. V. Kulikov, Yu. A. Nechin, S. P. Sokolov, V. I. Solov'eva (Solovieva), K. I. Solov'ev (Soloviev), Z. S. Strugalskiĭ (Strugalsky), and B. A. Khrenov. p.7-17 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The Moscow University installation represents an elaborate assembly consisting of simultaneously operating physical instruments, electronic devices, and a system of photographic cameras to record instrument readings during extensive air showers. The installation consists of counter hodoscopes containing 4400 G-M counters of area >100 m^2, ~150 ionization chambers of area 13 m^2, and a large diffusion cloud chamber of area 0.64 m^2. Each of the G-M counters and ionization chambers are connected to a channel of a pulse height analyzer. The installation was designed for a comprehensive and simultaneous investigation of all the major components (electrons, photons, radioactive particles, and μ-mesons) of extensive air showers at sea level. Information has been obtained on the lateral distribution of particles and energy fluxes of various components, including μ mesons and radioactive particles, even in individual showers. For a considerable part of the showers, data were obtained simultaneously on the electron-photon, the radioactive, and the μ-meson components of a given shower. Medium- and ultrahigh-energy showers were observed simultaneously. It is envisaged to supplement in 1960 the apparatus by a system of 20 luminescent counters with total area of 10 m^2, connected to a channel of an amplitude-to-time analyzer, as well as by a diffusion cloud chamber with ~5m^2 area. (B.O.G.)

4463 THE M. I. T. AIR SHOWER PROGRAM. B. Rossi. p.18-29 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The methods of detection and analysis were described at the Varenna Conference in 1957. Disks of scintillating plastics were used as detectors to obtain the direction of arrival of each shower from the time delays between pulses from the scintillators as they are struck, one after the other, by the shower front. In most experiments pulse heights were measured, from which values for the point of impact of the shower core, the density of shower particles as a function of distance from the core, and the total number of particles in the shower were obtained. Dr. Olbert has developed the mathematical theory of showers in a form that can be applied to a wide variety of assumptions concerning the still uncertain character of high-energy nuclear collisions. A summary is given of the results of the determination of the average longitudinal development of showers according to the models of high-energy interactions. These results are used in the interpretation of experimental data obtained. (B.O.G.)

4464 THE TOKYO AIR SHOWER EXPERIMENT. Fukui, Hasegawa, Matano, Miura, Oda, Ogita, Suga, Tanahashi, and Tanaka (Tokyo Univ.). p.30-43 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A description is given of experimental work in Japan on extensive air showers (EAS). Among the various purposes of the group, one was to investigate the fluctuations of the properties of EAS. The data obtained concerned the fluctuation of the shape of lateral distribution of particle density and the fluctuation of μ mesons. A graphical representation is given for the correlation between the fluctuations of lateral distribution and those of the μ mesons. Three sources of the fluctuations are conceivable: (1) those in the atmospheric depth of the first interaction for the development of EAS; (2) those in the nuclear interactions; and (3) the existence of heavy primaries. Source (1) was in-

vestigated to determine whether it could explain the observed fluctuations. Since all data are consistently and reasonably explained by this, it is conceivable that the majority of the fluctuations are caused in the depth of the first interaction. (B.O.G.)

4465 DESIGN AND PRELIMINARY RESULTS OF AN AIR SHOWER EXPERIMENT. K. Sitte, G. Davies, H. Kasha, N. Lerman, Y. Oren, A. Shapiro, I. Segal, and D. Stern (Israel Inst. of Tech., Haifa). p.44-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

An experiment is described which was designed to study the lateral distribution of Cherenkov pulses as a function of shower size and the interaction mean free path of shower primaries. The first subject was chosen in view of the possibility of using, at a later stage, microwave techniques, the efficiency of which has been demonstrated for showers with primary energies above $\sim 10^{17}$ ev. This experiment uses two Cherenkov light detectors in conjunction with an 8-tray hodoscope. The second problem requires the classification of showers according to age, size, and zenith angle. Age determination is achieved by measuring the energy of the nucleonic component near the core and recording the μ meson/electron ratio. Shower sizes are measured by the counter hodoscope, and the zenith angle classification is carried out by a direction sensitive core detector consisting of a flat Cherenkov counter viewed by 8 horizontally mounted photomultipliers and a lead-covered scintillation counter placed underneath. Results from preliminary experiments are discussed. (auth)

4466 ČERENKOV RADIATION PRODUCED BY EXTENSIVE AIR SHOWERS OF COSMIC RAY. A. E. Chudakov, N. M. Nesterova, V. I. Zatsepin, and E. I. Tukiš̆h. p.50-7 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Cherenkov radiation produced in the atmosphere was first discovered by Jelley and Galbraight. Later this phenomenon was used to study extensive air showers. This phenomenon makes it possible to establish the development of each recorded shower with respect to depth. A discussion is included of the results of measurements made in 1957 in the Pamirs at an altitude of 3860 m. An experimental arrangement is given showing the set-up of the ten light detectors and the nine hodoscope locations with Geiger counters. Two types of light detectors were used: (1) a photomultiplier with its photocathode upwards in a blackened aluminum tank at an optical angle of 50°, and (2) a 480-mm diameter parabolic mirror with the photocathode of a photomultiplier placed near its focal point. The effective area of these detectors was 600 m^2, and the optical angle was $-10°$. The detector array included six of the former type and four of the latter. Graphical representations are given of some of the results obtained. (B.O.G.)

4467 ON EXTENSIVE AIR SHOWERS AT 2770 m ABOVE SEA LEVEL. T. Kameda, T. Meeda, and Y. Toyoda (Kobe Univ., Japan). p.58-66 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A description is given of experiments on extensive air showers (EAS) conducted at 2770 m altitude. These experiments were designed to investigate the high energy electronic component near the axis of the EAS in as great a detail as possible and to increase the information available on the structure of EAS at this altitude on Mt. Norikura. The arrangement of the apparatus is given. The apparatus consists of five electron density detectors, each of which contains 20 large and 30 small counters with sensitive areas of 122 and 38 cm^2, respectively; a 250-channel neonhodoscope; and two cloud chambers, each of which has an effective area of 0.08 m^2 and contains nine lead plates of 1-cm thickness. A description is given of each of the methods used to find the size spectrum, zenith angle distribution, characters of high-energy electronic components at 0 to 10 m distances from the shower axis, lateral distribution of charged particles near the axis and location of the axis of the air shower. Graphical representations are included of the results of the measurements. (B.O.G.)

4468 AN AIR SHOWER EXPERIMENT AT MT. NORIKURA. S. Miyake, K. Hinotani, I. Katsumata, and T. Kaneko (Osaka City Univ.). p.67-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A description is given of an air shower experiment at Mt. Norikura. The arrangement of the experimental apparatus is given. The apparatus consists of a multiplate cloud chamber containing 21 lead plates measuring 2.0 × 1.3 × 0.9 in. ten scintillation counters of 50 cm square, and a neutron monitor that contains four BF_3 counters. Air showers are detected when the densities are greater than 200 particles per m^2. The scintillators are recorded logarithmically for a charged-particle density of 4 to 10^6 particles/m^2. The signals from the neutron monitor at 100 μsec after the shower arrival are recorded. The methods of analysis are described for the determination of lateral distribution of charged particles and nucleons, size distribution, and density distribution. The main interest in these experiments was in the fluctuations represented previously. An interpretation is being made of the results with respect to the fluctuations and mechanisms of high-energy interactions. (B.O.G.)

4469 SMALL AIR SHOWERS AT SEA LEVEL. R. F. Doolittle III and W. E. Hasen. p.69 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

An array of 27 ion chambers was used for a survey of air showers at sea level in order to determine the design of a more detailed study of the core of air showers. The axes of eleven showers struck the central area of 0.85 m^2 of the array for which the average trigger probability was 0.88. The absolute intensity was $(4.2 \pm 1.2)\ 10^{-6}\ m^{-2}\ sec^{-1}$ The Nishimura-Kamata lateral distributions were used to find the minimum shower size, which was $\sim 3 \times 10^4$ electrons. This absolute intensity agrees with the intensities deduced from G-M counter measurements. In 16 of the 18 cases in which axes struck within the central array only one core was observed. One event had two cores separated by 1 or 2 meters. One event contained 3 cores separated by 2 to 3 meters. (auth)

4470 INVESTIGATING CORES OF INDIVIDUAL AIR SHOWERS. N. N. Goryunov, A. D. Erlykin, G. T. Zatsepin, and A. B. Kamnev. p.70-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The main part of the installation designed for the investigation of particle fluxes in extensive air showers (EAS) consists of a system of ionization chambers shielded by layers of materials having various atomic numbers. This arrangement makes possible the determination of various shower components. The ionization chambers are arranged in two trays, one over the other, containing 60 and 64

counters in the upper and lower trays, respectively. A cross-sectional diagram is given of the arrangement of the trays. The upper tray is shielded with 2.5 cm lead and registers the flux of particles generated in the lead by high-energy electrons and photons. The trays are separated by a complex Pb-C-Pb absorber. The lower tray registers the fluxes generated in this absorber by high-energy radioactive particles. The bursts detected by the lower chambers are mainly from the electron-photon components produced by nuclear interactions in the carbon layer. When treating the results, principal attention was given to the cases where shower cores passed through the chamber system. According to the electromagnetic cascade theory, the axes of powerful showers of sufficiently large size may be localized in a small region caused by a drastic increase in the density of the energy flux there. The number of events with sharp nonuniform ionization distributions, when there is a region where the ionization is a maximum, is equal to the calculated number of shower cores with $N > 10^5$, using the methods of Strugalsky for the calculations. A description is given of the characteristics found for the shower cores. (B.O.G.)

4471 ABSORPTION LENGTH VS. SIZE OF EXTENSIVE AIR SHOWERS(EAS). J. Delvaille, F. Kendziorski, and K. Greisen (Cornell Univ., Ithaca, N. Y.). p.79-83 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

An equation is given for the absorption length, λ, of extensive air showers (EAS): $\lambda^{-1} = -(1/I)(\partial I/\partial \chi)$, where I is the intensity of the EAS containing N charged particles at an atmospheric depth, χ, measured along the shower axes. It is tacitly assumed, in agreement with many experiments, that the intensity at equal values of χ is independent of the angular coordinates of the axes. The absorption length was measured by two methods: (1) by the barometric effect and (2) by the zenith angle dependence of the showers. From the tabulated data, it can be seen that there is no indication of any significant variation of λ with N, the number of charged particles. The present results are in marked disagreement with the values of λ, ranging from 80 to 98 g/cm^2, reported by the Harwell and M.I.T. groups. A search was made for any systematic error that could cause the discrepancy, but none was found. More recent M.I.T. results were reported as 107 ± 5 and 113 ± 9 g/cm^2, which reduced the discrepancy but did not eliminate it. If λ is quite large, fluctuations in the points of initiation of the shower could still be of great importance if the primaries interact with a cross section much less than the geometric value or if the initial interaction fluctuates widely in elasticity, often resulting in very little energy transfer. The primaries must be protons rather than heavy nuclei. The fluctuations in secondary interactions lead to a long attenuation length of the nuclear cascade, sufficient in itself to account for the large value of λ even if the primaries are heavy nuclei and the initial interactions all occur at high altitude. (B.O.G.)

4472 THE ABSORPTION OF AIR SHOWERS. J. Malos (Univ. of Sydney). p.84 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The zenith angles of showers were determined in the Sydney Air Shower Experiment by a fast timing method. The absorption length of showers was determined after applying various corrections and found to be: $\Lambda_1 = 125^{+19}_{-17}$ g/cm^{-2} for showers of 3×10^5 particles and $\Lambda_2 = 107^{+16}_{-19}$ g/cm^{-2} for showers of 8.5×10^5 particles. The present results are compared with those of other experiments. (auth)

4473 SPECTRUM OF EXTENSIVE AIR SHOWERS IN NUMBER OF PARTICLES AT 200 AND 3860 METERS ABOVE SEA LEVEL. G. V. Kulikov, N. M. Nesterova, S. I. Nikolskiĭ (Nikolsky), V. I. Solov'eva (Solovyeva), G. B. Khristiansen, and A. E. Chudakov (Moscow State Univ.). p.85-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A discussion is given of data obtained on the spectra of extensive air showers (EAS) at sea level and at an altitude of 3860 m for numbers of particles in the interval 4×10^3 to 3×10^7. The most direct way to obtain this information is to study individual showers. When applied to the study of the interval $N = 10^3$ to 10^4, this method gives rise to considerable difficulties connected with the determination of the flux density of the charged particles. For this reason the spectrum of showers was studied statistically for the interval $N = 10^3$ to 10^8. Three sets of arrangements are shown: (1) $N = 10^3$ to 5×10^4; (2) $N = 10^5$ to 10^6; and (3) $N > 10^7$. (B.O.G.)

4474 STUDY OF EXTENSIVE AIR SHOWERS OF SUPERHIGH ENERGY. A. T. Abrosimov, G. A. Basilevskaya, V. I. Solov'eva (Solovieva), and G. B. Khristiansen. p.89-95 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Extensive air showers having 5×10^6 to 10^8 particles were studied. Data are given on the absolute shower intensity and the spectral exponent with respect to the number of particles as well as on the spatial distribution of the electron-photon component and μ mesons. The data on the electron-photon component show that in the lower atmosphere there is no equilibrium between the electron-photon component and the nuclear component in showers of superhigh energy, and that the spatial distribution of electrons is determined not only by Coulomb scattering but by the angular divergence of particles during nuclear cascade processes and spontaneous decays. (auth)

4475 AIR SHOWERS AT ALTITUDES OF 9-12 km. R. A. Antonov, Yu. A. Smorodin, Z. I. Tulinova (Lebedev Inst. of Physics, [Moscow] and Moscow State Univ.). p.96-100 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A study was made of the density spectra of extensive air showers at 9 to 12 km altitude by an array of hodoscope counters operated in the regime of controlled pulse supply. An arrangement is given for the counter boxes, nine of which have five each MS-9 type counters with an area of 86 cm^2, and fifteen have the MS-13 type counter. The possibility of more than one particle penetrating the counter was considered as well as random coincidences and spontaneous ignitions. These last effects were registered on a flight during 1-min control intervals and constituted 0.1% of the total number of master impulses per counter. The relation between the counter areas by this determination was 16 ± 0.4. Data are tabulated for: (1) the number of master phenomena recorded per hour at various altitudes; (2) values for constants in the equation for the spectra at different altitudes; (3) lateral distributions of axes at various shower densities at 9 and 12 km; (4) lateral distribution of electrons in EAS changes with altitude changes; and

(5) the number of primary particles with energies higher than E_0 for 5×10^{14}, 5×10^{15}, and 5×10^{16}. (B.O.G.)

4476 INDEPENDENCE OF LATERAL DISTRIBUTION AND SIZE OF EAS. J. Delvaille, F. Kendzierski, and K. Greisen (Cornell Univ., Ithaca, N. Y.). p.101-5 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The exponent, γ, in the number spectrum of EAS, $K(>N) = K_0N^{-\gamma}$, has been measured previously by two methods. The older method, which is simpler and more precise statistically, is to measure the density spectrum. The newer method is to make observations on each shower, measuring the density of particles at various spatial locations. From these data a determination is made of the location of the axis and the total number of particles for each shower. The number of showers with axes crossing unit area and size exceeding N yields K(N) directly. The results from these methods have shown discrepancies. For densities of 10^2 to 10^3 m^{-2}, caused mostly by showers of 10^6 to 10^7 particles, the density spectra measured with a compact counter array yielded a value of γ slightly less than 1.60. The "direct" measurements of showers in the same range of particle numbers yielded a value of γ close to 1.90. Data are shown for the density spectrum, which was taken by recording the pulse height distribution in a single scintillator. At a mean density of 10^3 m^{-2}, corresponding to showers of $N \cong 10^7$ particles, it is concluded that $\gamma = 1.62 \pm 0.04$. (B.O.G.)

4477 ON THE FUNCTION OF LATERAL DISTRIBUTION OF CHARGED PARTICLES AND OF THE DENSITY OF THE ELECTRON-PHOTON COMPONENT ENERGY FLUX IN AN EXTENSIVE AIR SHOWER. S. N. Vernov, N. N. Goryunov, V. A. Dmitriev, G. V. Kulikov, Yu. (Ju.) A. Nechin, V. I. Solov'eva (Solovieva), Z. S. Strugalskiĭ (Strugalsky), and G. B. Khristiansen. p.109-14 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Data obtained by the diffusion cloud chamber and the hodoscope counters permit the identity of the distribution of shower particle fluxes near the axis of the shower and at great distances from it. The data can be used to find the number of particles in the shower and the position of the axis within ~1 in. by the hodoscope counters and within several cm if the axis gets within the boundaries of the diffusion cloud chamber. The distribution of energy flux carried by the electron-photon component near the shower axis is determined by the first tray of ionization chambers, which are shielded on all sides with lead. Since they are shielded on all sides, the cascade theory for heavy elements can be used without limitations to interpret the experimental data. The most dense of the 20,000 EAS recorded during the operation of the installation were selected and investigated. The results are discussed in accordance with individual and mean characteristics of the air showers. The experimental data show the presence of considerable fluctuations in the absolute energy fluxes of electron-photon components and in the lateral distribution of such fluxes. The dependence of mean energy on the distance points to the substantial role of nuclear scattering. (B.O.G.)

4478 INVESTIGATION OF HIGH-ENERGY NUCLEAR-ACTIVE COMPONENT OF EXTENSIVE AIR SHOWERS AT SEA LEVEL. S. N. Vernov, N. N. Goryunov, V. A. Dmitriev (Dmitriyev), G. V. Kulikov, Yu. A. Nechin, and G. B. Khristiansen. p.115-21 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

It is shown that the radioactive component in sea-level showers with N values of 10^4 to 10^6 carries an energy that approximates that carried by the entire electron-photon component at the observation level. The energetic role of the radioactive component differs essentially in individual showers with identical numbers of particles. Because of this, the mechanism of development of individual showers undergoes substantial changes as compared with the development of other showers. The lateral distribution of energy flux of this component in the region $1 \leq r \leq 10$ m from the axis is described by the law $r^{-2.0 \pm 0.25}$. Such an energy distribution should affect the characteristics of the soft component. (B.O.G.)

4479 STUDY OF THE ELECTRON-PHOTON COMPONENT OF EXTENSIVE AIR SHOWERS NEAR THE SHOWER AXIS. O. I. Dovzhenko (Dovzenko), S. I. Nikol'skiĭ (Nikolsky), and I. V. Rakobol'skaya (Rakobolskaja). p.122-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A cloud chamber equipped with lead plates was used to investigate the electron-photon component of extensive air showers. This usage makes it possible to obtain a visual form of energy spectra for the electrons and photons from the cascade showers produced in the lead plates. The energy of electrons and photons incident on the upper surface of the chamber was determined by the total number of particles in the upper five compartments in the region of the cascade shower maximum. From the control arrangement calculations, the distribution of the showers registered by the installation was determined with reference to the shower axis. In 70% of the cases the shower axes passed within 3 m of the chamber. From these measurements, the integral energy spectra of the electron-photon components were determined. Energies are graphically represented for measurements taken at Moscow and the Pamirs. In the showers registered, the fraction of electrons and photons of high energy in the total number of particles was not found to increase. A comparison of the experimental results with those predicted by the electromagnetic cascade theory showed that the experimental spectra had fewer electrons of high energy near the shower axis. The contribution of photons was considered by calculating the spectrum for electrons and photons at $s = 1.2$ and infinite initial energy. The total energy spectrum thus obtained within 3 m of the axis coincides with the spectrum for the same distances for electrons at $s = 1.5$. A tabulation is given of results calculated for the fraction of electrons and photons of high energy relative to the total number of electrons in the shower from the electron-photon spectrum at $s = 1.2$. As seen in the graphical representation, the theoretical spectrum differs considerably from the experimental results. This discrepancy is probably caused by the fact that in theoretical calculations, the initial conditions for production and growth of the electron-photon component of the shower were improperly taken into consideration. Using the results obtained, the lateral distribution of high-energy electrons and photons was found in the region of the shower core within 3 m of the shower axis. (B.O.G.)

4480 SPATIAL DISTRIBUTION OF THE ENERGY FLOW OF E.A.S. ELECTRON-PHOTON AND NUCLEAR-ACTIVE COMPONENTS AT AN ALTITUDE OF 3860 METERS ABOVE SEA LEVEL. S. I. Nikol'skiĭ (Nikolsky) and E. I. Tukish (Lebedev Inst. of Physics, [Moscow]).

p.129-33 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Measurements were carried out at 3860 m altitude in the Pamirs at a station set-up for studying extensive air showers. The density of energy flow was determined by 12 cylindrical ionization chambers placed under lead absorbers of various thicknesses. The position of the shower axis and the number of shower particles were determined by a hodoscope system consisting of 1000 counters. This apparatus made it possible to obtain the spatial distribution of energy flow density at an interval of 0.2 to 30 m from the axis in showers of 2×10^5 to 4×10^5 ($\overline{N} = 3 \times 10^5$) particles and at distances of 0.2 to 20 m in showers of 6×10^4 to 12×10^4 ($\overline{N} = 10^5$) particles. The energy flow density at a given distance from the axis was found from the cascade curve obtained for depths of 80 cm of lead, using the equation: $\rho_E = \beta \int_0^\infty N(t)dt$, where $\beta = 6.4 \times 10^6$ ev is the critical energy of electrons in lead, and t is the depth of the absorber in cascade units. N(t) is the density of the particle stream in the cascade at depth t, determined by the ionization in the chambers. Graphical representations are given for: cascade curves in showers with $\overline{N} = 3 \times 10^5$ and $\overline{N} = 10^5$ at the interval 1 to 2 m, which includes corrections for transition effects in the walls of the ionization chambers and for the angular distribution of the showers; the spatial distribution of the energy flow densities in showers with $\overline{N} = 3 \times 10^5$ and $\overline{N} = 10^5$ particles; and data on the spatial distribution of energy flow density for the electron-photon components in showers with $\overline{N} = 3 \times 10^5$. (B.O.G.)

4481 ON THE ENERGY SPECTRUM OF NUCLEAR-ACTIVE PARTICLES FROM COSMIC RAYS AT AN ALTITUDE OF 3860 METERS AND THE ASSOCIATED EXTENSIVE AIR SHOWERS. O. I. Dovzhenko (Dovzenko), G. T. Zatsepin (Zatcepin), E. A. Murzina, S. I. Nikol'skiĭ (Nikolskij), and V. I. Yakovlev (Iakovlev). p.134-41 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The energy spectra of nuclear-active particles were studied at an altitude of 3860 m in 1955 and 1957. The main features of each installation set-up are described. The 1955 experiment embodied a single tray of ionization chambers of 1 m^2 area with a layer of lead 20, 50, or 80 cm thick placed over it. In the 1957 experiment, 15 ionization chambers were placed in two trays, one above the other, whereby the working area of each tray was 2.25 m^2. Each tray was covered by layers of lead, graphite, and lead with thicknesses of 2 cm, 39 or 65 cm, and 4 cm, respectively. The graphite served as the absorber and the 2 cm lead plate served to reduce the influence of the electron-photon components. Simultaneously with the ionization bursts, the accompanying air was observed in the detector of nuclear-active particles. From a plot of the energy spectra of nuclear-active particles in both experiments, it can be seen that the integral energy spectra in the range 10^{12} to 5×10^{13} may be expressed in the form: $f(>E) = AE^{-\gamma}$, where $\gamma = 1.5 \pm 0.1$. The energy spectrum for nuclear-active particles averaged over a wide range of distances and the total number of charged particles in the shower were determined from the experimental information. On the basis of the 1957 data, a study was made of the relation between the number of nuclear-active particles with energies $>2 \times 10^{12}$ ev and the total number of particles in the shower. The results are shown graphically as the dependence of the number of nuclear-active particles on the number of particles in the shower, expressed as $\sim N^{1.5}$. (B.O.G.)

4482 ABSORPTION OF HIGH-ENERGY NUCLEONS IN THE ATMOSPHERE. L. T. Baradzei (Baradzey), V. I. Rubtsov, Yu. A. Smorodin, M. V. Solov'ev (Solovyov), and B. V. Tolkachev (Tolkachov). p.142-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Instruments were carried aloft by an airplane, and information concerning ionization bursts at various altitudes was recorded. Instrument I contained two trays of ionization chambers located under 4 and 8 t-units of lead and registered bursts of 150 to 5000 relativistic particles. Instrument II contained 15 ionization chambers under a lead plate 10 t-units thick and had an area of 1.3 m^2. The apparatus recorded ionization in each chamber if the total ionization in a tray exceeded that produced by 150 relativistic particles in Instrument I and by 2000 relativistic particles in Instrument II. A layer of graphite having a thickness of 30 gm/cm^2 was placed over the apparatus to detect the nuclear active particles. The energy spectra of electron-photon avalanches incident from the air were obtained at energies of 2×10^{10} to 5×10^{11} ev. Instrument II made it possible to extend the spectra to energies of 2×10^{12} ev. It was found that for pressures of 200 and 310 gm/cm^2, out to a distance of 10 m, the electron density decreases according to $r^{-0.7 \pm 0.1}$. The included data show that the photons under consideration are effectively formed by nuclear-active particles with an energy exceeding that of the photons by a factor of ~100. Comparing the observed intensity of showers accompanying the electron-photon avalanches with the intensity of primary particles, the obtained estimate should be correct provided the share of multi-charged particles in the primary cosmic radiation, at energies of 10^{13} to 10^{14} ev, is not great. The absolute intensity of the nuclear-active component was obtained on the assumption that a high-energy nucleon interacting with a carbon nucleus imparts 10% of its energy to π^0 mesons. The results obtained indicate that the absorption range does not change noticeably up to energies of $\gtrsim 10^{13}$ ev. (B.O.G.)

4483 STUDY OF THE ENERGY SPECTRUM OF EXTENSIVE AIR SHOWER PENETRATING COMPONENT. E. L. Andronikashivili and R. E. Kasarov. p.149-51 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The energy spectrum of the penetrating component of the extensive air shower (EAS) was investigated through the absorption of μ mesons contained in a shower at various depths underground. The above-ground equipment consisted of three groups of G-M counters used as a shower-selecting array placed in a circle of 1-m radius and connected with four hodoscope trays. The underground equipment consisted of two trays one-meter-square each, arranged one over the other and divided by an 8-cm lead plate. In all cases the detector was under the shower-selecting array center. The effective distance of an underground tray at great depths corresponded to a distance of 28 m to the shower axis. The shower axis location and size was determined with an accuracy of ±50%. The penetrating component density was defined by a ratio of the number of showers with an underground accompaniment to the total number of showers of a given value in accordance with the equality: $C_{(\text{underground})}/C_{(\text{all})} = 1 - e^{-\Delta}$. Graphical representations are given for the energy spectra at an average distance of ~28 m from the axis for penetrating particles in showers with $\overline{N} = 1.4 \times 10^4$ and 2.9×10^5 and of the μ-meson component in the shower for $\overline{N} = 1.4 \times 10^4$, 7×10^4, and 2.9×10^5. (B.O.G.)

4484 A TRIGGERED SPARK COUNTER TELESCOPE INVESTIGATION ON THE MU-MESON COMPONENT OF EXTENSIVE AIR SHOWERS. T. E. Cranshaw, J. F. deBeer, and A. G. Parham (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.152-4 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The apparatus consisted of two triggered spark counter μ-meson telescopes, separated by 500 m and operated in conjunction with an extensive air-shower array. Both telescopes were triggered whenever the array detected a shower. The attenuation lengths of air-shower μ mesons in the atmosphere were determined as: 320 gms/cm^2 between 0 and 200 m from the shower core; 1300 gms/cm^2 at 200 to 400 m distance; and ~2700 gms/cm^2 at distances > 400 m from the shower core. It is concluded that this difference in the attenuation length should be attributed to a change in the structure function of μ mesons with zenith angle. If this is correct, the μ-meson density at 500 m from the core is 2 to 3 times higher for showers with a zenith angle of 40° than for vertical showers. The integral momentum distribution is shown for the range 0.3 to 0.7 Bev. At depths >200 gms from the top of the atmosphere, the production of μ mesons seems to take place at a uniform rate independent of depth. An unexpectedly large number seems to originate from depths <200 gms. A very efficient process of μ-meson production is required to account for the large number of mesons created at great heights. (B.O.G.)

4485 ON FLUCTUATIONS IN NUMBER OF μ-MESONS IN EXTENSIVE AIR SHOWERS. B. V. Kalachev (Kalachyov), S. I. Nikol'skiĭ (Nikolsky), A. A. Pomanskiĭ (Pomansky), and E. I. Tukish (Lebedev Inst. of Physics, Moscow). p.155-7 of "Proceedings of Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The results are given from experiments conducted to detect fluctuations in the ratio of the numbers of μ mesons and electrons in showers of from 10^5 to 2×10^6 particles at an altitude of 3860 m. A description is given of the experimental arrangement. On the basis of data collected for the density of the flux of μ mesons in showers with a different number of particles, it is possible to calculate the spectrum of the showers according to the number of particles recorded. Calculated and experimental data are plotted for the distance interval of 40 to 50 m between the shower axis and the master group of counters, from which it is seen that showers with $N \leq 10^6$ were greater than predicted by calculations. (B.O.G.)

4486 INVESTIGATION OF FLUXES OF HIGH-ENERGY MU-MESON COMPONENTS OF EXTENSIVE AIR SHOWERS. S. N. Vernov, V. I. Tulupov, B. A. Khrenov, and G. B. Khristiansen. p.158-69 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The fluxes of high-energy μ mesons in extensive air showers were investigated by selecting the components having different energies from those registered at different depths of the absorber. A description is given of the experimental set-up showing the arrangements of the lead-shielded G-M counters, above and below ground, and the hodoscopes. In investigating the fluxes of high-energy μ mesons, it is necessary to select showers with axes located at different distances from the μ-meson detectors in order to investigate the lateral distribution of the fluxes. The location of the shower axis at 0 to 5 m and 22 to 27 m from the detectors and the number of shower particles were determined individually for each particular shower by using the known function of the lateral distribution of charged particles in the shower. The flux density of μ mesons having energies >0.4 Bev was determined from data from the aboveground detector. The flux density of those whose energies exceeded 5 Bev and 10 Bev were determined by the underground detectors. The irregularities of the lateral distribution of μ mesons were investigated at a depth of 40 mwe in individual showers by type b detectors of total area 3.1 m^2. The lateral distributions of 10-Bev μ mesons were concluded to be affected by the angular distributions of π mesons in nuclear interactions. The bulk of μ mesons with $E_\mu \geq 10$ Bev was found to be produced at 6 to 8 m above sea level. The dependence of the number of μ mesons with $E_\mu = \geq 10$ Bev, within a 25-m radius, on the number of shower particles has the form $N^{0.6 \pm 0.05}$ in the range $N = 10^4$ to 5×10^5. The lateral distribution for μ mesons with energies of ≥10 Bev in showers with $N = 2 \times 10^5$ has the form $1/r^n$, $n = 0.8 \pm 0.2$ for $r = 3$ to 10 m from the shower axis. (B.O.G.)

4487 MULTIPLE PENETRATING PARTICLES AT 50 M.W.E. AND AT 250 M.W.E. UNDERGROUND. S. Higashi, S. Mitani, T. Oshio, H. Shibata, K. Watanabe, and Y. Watase (Osaka City Univ.). p.170-3 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Observations were made of underground hard showers at depths of 50 and 250 mwe from the top of the atmosphere, using a cloud chamber and several trays of hodoscoped G-M counters. Cloud-chamber pictures were obtained showing bundles of penetrating particles (pps) besides the hard showers. In the analysis of the data, the pictures were classified according to the number of pps per picture. Multiple penetrating particles MPPs were registered as events that satisfy the following two conditions: (1) four or more pps fall onto the cloud chamber simultaneously, showing parallel features within ±5°, and (2) the pps do not converge to a point above the chamber. Considering parallelism of each MPPs track, it is natural that the origins would be in the atmosphere. These results are compared with results obtained by Kessler et al. at 65 mwe. Discussions are given concerning the frequencies and the density and energy spectra of the MPPs. (B.O.G.)

4488 DISTRIBUTION OF POINTS OF INITIATION OF EAS. K. Greisen, J. Delvaille, and F. Kendziorski (Cornell Univ., Ithaca, N. Y.). p.174-5 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Quantitative conclusions concerning the origin of extensive air showers (EAS) cannot be reached theoretically without knowing the charge spectra of high-energy primaries, the effective cross section for shower initiation, and the law of fluctuation in elasticity and multiplicity of first collisions. Under the most extreme assumptions, the apparent absorption rate of EAS would be a measure of shower initiation cross section, not of the rate of absorption of secondaries. An extended array of scintillators made it possible to test a model for extreme fluctuations. Showers were selected in which four counters lying approximately in a line, extending across the full diameter of the array were discharged. Each shower was analyzed so that the perpendicular distance from the axis to each counter was known. The showers were rather large; the logarithmic mean value of the number of particles was $\sim 3 \times 10^7$. The results agree with those of Chudakov et al., obtained

by comparing the Cherenkov light intensities in showers of the same number of particles at different elevations and by observing the fluctuations in the light intensity at a fixed elevation. (B.O.G.)

4489 THE DISTRIBUTION IN DECLINATION AND THE CURVATURE OF THE SHOWER FRONT. E. F. Bradley and N. A. Porter (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.176-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A directional Cherenkov counter was used in conjunction with the extensive air shower array at Culham, England, to look for an asymmetry in the arrival directions of air showers containing at least 3×10^6 particles at sea level. Three phototubes connected in parallel were mounted in optical contact at each of the end faces of the Cherenkov detector. A particle incident normally to the array gave a signal approximately equal in both sets of photomultipliers. An obliquely incident particle gave a signal larger in the photomultiplier toward which it was directed. A calculation showed that for showers averaged over all azimuth and zenith angles, using a zenith angle distribution, the mean pulse in the preferred channel was ~3 times that in the other. The probability, averaged over-all azimuth and zenith angles, that a single particle was assigned to the wrong class was estimated to be 0.07. The observed directional asymmetries lend confidence to the belief that the directional discrimination of the counter was reliable. This asymmetry was used to estimate the directional radius of curvature by assuming the zenith angular distribution of the showers and carrying out a numerical integration over each half annulus. Taking a mean value over the whole annulus 80 m to 320 m, the mean directional radius is 1625^{+805}_{-290} meters. Assuming Coulomb scattering to be dominant in causing the lateral spread of shower particles, the corresponding radius of curvature would be 2440^{+760}_{-430} meters. (B.O.G.)

4490 AN EXPERIMENT TO CHECK AN APPARENT NORTH-SOUTH ASYMMETRY IN ARRIVAL DIRECTION OF COSMIC RAY AIR SHOWERS OF 10^6 PARTICLES. C. B. A. McCusker, J. Malos, and P. C. Poole (Univ. of Sydney). p.179-84 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The existence of an apparent asymmetry in arrival directions was noted in a preliminary analysis of shower directions obtained in the Sydney Air Shower Experiment. An experiment was set up within the confines of the air-shower array to investigate the asymmetry. From an analysis of the results, it was concluded that there is no asymmetry in the arrival direction of air showers as measured by fast timing techniques. Observed asymmetry is caused by scattering on the roof of the building where the measurements were taken as were the asymmetries observed in the counter telescope experiment. The position and layout of any experiment using scintillators and fast timing techniques to measure shower arrival directions should be carefully chosen and checked for any object which could conceivably cause scattering of cosmic electrons. Similar care should be taken with the location of devices measuring electron densities for the examination of electron structure of showers or the locations of their cores. (B.O.G.)

4491 ON SOME PROPERTIES OF EXTENSIVE AIR SHOWERS OBTAINED BY CONTINUOUS RECORDING OF SHOWER FREQUENCY NEAR SEA LEVEL. D. D. Krasilnikov (Yakutsk Cosmic Ray Lab., Siberian Branch, Academy of Sciences, USSR). p.188-91 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

An array of 360 G-M counters was assembled and installed at Yakutsk, 100 m above sea level, to record time variations of the frequency of extensive air showers (EAS) having various average numbers of particles. The equipment used in this study was previously described. Some results from recording EAS frequency for 1958 and early 1959 are discussed as: (1) the EAS spectrum with respect to the number of particles at sea level; (2) barometric effect of EAS frequency for various $\bar{N}$; and (3) temperature effect and seasonal dependence of EAS frequency. (B.O.G.)

4492 THE ROLE PLAYED BY FLUCTUATIONS IN THE DEVELOPMENT OF AIR SHOWERS. G. T. Zatsepin. p.192-200 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Results from past air-shower studies permit the characteristics of nuclear cascade development to be obtained, along with certain data concerning the characteristics of elementary processes of nuclear collisions that occur at superhigh energies. One of the most important results obtained on the basis of data from numerous experiments is the exponential decrease in the lower third of the atmosphere of the number of recorded showers having a given number of particles. An approximate solution is derived which relates the role of fluctuations in the development of showers by considering free-path fluctuations and the energy loss of high-energy nucleons. Comparisons of results indicate that if fluctuations are considered in the development of showers the value obtained from analysis of altitude dependence of showers for the average fraction of energy retained in nuclear collisions of high-energy nucleons is less than that obtained considering averaged values. The development of showers from protons of low energy ($E \lesssim 10^{15}$ ev), proceeds with large fluctuations because the secondary avalanches created during nuclear collisions of nucleons are short and because in the majority of nuclear collisions the nucleon retains a considerable fraction of its energy. Because of the steep drop in the form of the primary proton spectrum, the average energy of the primary particles responsible for the formation of avalanches with a given N at the observation level is less than the energy of the primary particles creating, on the average, the same number of particles. Nucleons of high energies retain a considerable fraction of their energy in most nuclear collisions. Experimental data are in agreement with the assumption that π mesons in nuclear collisions lose a tremendous amount of energy. (B.O.G.)

4493 CALCULATION OF SOME CHARACTERISTICS OF AIR SHOWERS TAKING FLUCTUATIONS INTO ACCOUNT. L. G. Dedenko and G. T. Zatsepin. p.201-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The probability of showers having a given number of particles at sea level being produced by primary protons of various energies was calculated by the Monte Carlo method. A description is given of the basic assumptions used in the calculations. The results of the calculations are discussed according to: (1) the probability distribution function of the logarithm of the number of particles at the observation level caused by a primary proton of fixed energy; (2) the probability distribution function of the logarithm of the

energy of primary protons generating showers with a given number of particles at the observation level; (3) the shower spectrum with respect to the number of particles and the primary proton spectra; and (4) the density of nucleon collisions in the atmosphere. A generalization is given of the calculation methods for the case when the primary particle is a nucleus with atomic weight A. (B.O.G.)

4494 A MODEL FOR THE INTERPRETATION OF AIR-SHOWER DATA. T. E. Cranshaw and A. M. Hillas. p.210-13 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A model was developed from previously reported data concerning the barometric coefficient of air showers for the interpretation of data obtained in the study of air showers. Contradictions appear in this development because of assumptions made concerning the unique curves of cascade development for primaries of a given energy. The consequences of the model on the deduction of a primary spectrum are complicated, but do not substantially affect previously published values. (B.O.G.)

4495 DEPENDENCE OF VARIOUS EXTENSIVE AIR SHOWER CHARACTERISTICS ON TOTAL PARTICLE NUMBER. S. I. Nikol'skiĭ (Nikolsky) and A. A. Pomanskiĭ (Pomansky) (Lebedev Inst. of Physics, Moscow). p.214-19 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The location of the axis and a knowledge of the total number of particles for each shower made it possible to determine the dependence of various characteristics of extensive air showers (EAS) on the total number of particles by statistical processing. The shower range investigated was divided into seven groups according to the total particle number from $N = 10^4$ to 10^6. For showers with $N < 10^5$, the calculated characteristics agree well with the experimental values. An exception is the energy spectra of nuclear-active particles at energies $>10^{12}$ ev. Agreement is worse for showers with $N > 10^5$. The calculated values of the numbers of nuclear-active particles and their energies exceed considerably those experimentally observed. Additional calculations were made on the assumptions that in nuclear interactions at energies $>10^{14}$ ev the multiplicity of the production of secondary particles and their energy distribution correspond to Heisenberg's model, and that at primary nucleon energies $>10^{14}$ ev an electron-photon component is produced, but not via π^0 mesons. For the latter case, the energy, Δ, transferred to the electron-photon component comprises 0.63 of the primary particle energy. The introduction of the second assumption makes it possible to fit the experimental with the calculated results in respect both to the number of nuclear-active particles and the magnitude of the energy carried by the nuclear-active component of the shower. (B.O.G.)

4496 HIGH ENERGY NUCLEAR INTERACTIONS AND EXTENSIVE AIR SHOWERS. S. Hayakawa and N. Ogita (Kyoto Univ.). p.220-3 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A recent observation made by Fujimoto et al. revealed the photon energy spectra shows for a mountain altitude a discontinuity at $\sim 10^{12}$ ev. This fact may be construed to indicate that features of nuclear interactions change as the energy of incident nucleons increases. The observation that the change occurs at a nucleon energy of $\sim 10^{14}$ ev was developed in the following ways: (1) any change in nuclear interactions affects the N-cascade, so that the energy spectra of N-particles have a nick; then the photon energy spectra resulting from the N-particles could have a nick unless the cross section for pion production showed anomaly at any energy. (2) Pions could be produced with relatively low energies above the critical energy, but the energy spectrum of N-particles is essentially smooth. An examination was made to determine which is the more effective—a nick in the N-particle energy spectrum or a nick in the pion production cross section. The N-particle spectrum seems to be only slightly responsible for the nick in the photon spectra, but it may be accounted for if few pions with energies higher than 10^{12} ev are produced. This is further investigated through the connection with the multiple pion production mechanism by reference to the fireball model which seems to explain essential features of interest. (B.O.G.)

4497 THEORETICAL ANALYSIS OF EXTENSIVE AIR SHOWERS. H. Fukuda (Tokyo Inst. of Tech.), N. Ogita, and A. Ueda. p.224-7 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

An extensive air shower (EAS) is a very complicated phenomenon consisting of various processes in which the particle energies cover a wide range. To obtain information on elementary nuclear interactions, processes are chosen that are caused by particles having energies $\gtrsim 10^{12}$ ev. In this energy region, it is hoped that the characteristics of elementary interactions are well defined and not subject to large fluctuations for both nucleon- and pion-nucleus collisions. Experimentally measurable quantities were chosen because they are strongly affected by the dynamical characteristics of elementary interactions. Phenomenological models were adopted as comprehensively as possible considering all existing theories of multiple particle production and consistent with experimental values. Calculations using model I show that the inelasticity strongly affects the altitude variation of the electron component, whereas those for model II show that the energy spectra of secondary particles also has a strong effect. The lateral distribution of high-energy muons does not depend strongly on the inelasticity, although the inelasticity may affect the total number of mesons. Apart from the direct connection of the structure of EAS with elementary interactions, EAS has a striking feature that the lateral distribution is independent of shower sizes and altitudes where observations were made. It is noted that both the calculated and experimental results are based on the statistical treatment. (B.O.G.)

4498 THREE-DIMENSIONAL DEVELOPMENT OF ELECTRON-PHOTON CASCADE SHOWERS. V. V. Guzhavin and I. P. Ivanenko (Moscow Univ.). p.231-42 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Experiments conducted lately require that the cascade theory give the exact behavior of functions of angular and lateral distributions of particles around the shower axis. In most cascade theory studies, the functions are calculated assuming that the energy of the primary particle $E_0 = \infty$. This assumption is apparently not valid near the axis of the shower where the energies of the electrons and photons are close to E_0. A method is derived which makes it possible to obtain approximate values for functions for any finite value of E_0 where $[(E_0/E) > 10]$, using the known distribution functions calculated for $E_0 = \infty$. The method was used to calculate the "equilibrium" functions of angu-

lar distribution. A graphical representation is given of a comparison of the calculated and exact functions. The accuracy of the curves obtained is ~10 to 20%. (B.O.G.)

4499 COMPARISON OF THE ELECTRON NUMBER DISTRIBUTION IN ELECTRON-PHOTON SHOWERS IN AIR AND ALUMINIUM ABSORBERS. J. C. Butcher and H. Messel (Univ. of Sydney). p.243-55 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Numerical results for the number distribution of electrons exceeding a given energy from primary electrons and photons in air showers are compared for air and aluminum absorbers. Comparisons were made for electron-photon primaries at 500, 2,000 and 10,000 Mev; and secondary electron energies of 5, 20, and 100 Mev. Graphs are given for the average numbers and the probability of finding >3 electrons at a given absorber depth. Twelve sets of curves are included for the probability of finding individual numbers of electrons. The Bethe-Heitler cross sections at low energies are used; collision losses and Compton effects are considered, but scattering at low energies is neglected. The results were obtained by using Monte Carlo methods on the SILLIAC. (auth)

4500 DEVELOPMENT OF ELECTRON-PHOTON SHOWERS OF HIGH ENERGY IN CONDENSED MEDIA. T. G. Volkonskaya, I. P. Ivanenko, and G. A. Timofeev (Timofeyev). p.256-76 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A theoretical study was recently made of the effect of multiple electron scattering on atomic nuclei in condensed media, the influence of the refractive index of a medium on bremsstrahlung processes, and pair formation at high energies. To experimentally check these effects, the development of a cascade shower should be calculated on the first t-units with new cross sections. Pair-formation processes, bremsstrahlung, and ionization of the atoms of the media were taken into consideration in the Monte Carlo calculations. In the region of high energies where the effects of multiple scattering are of importance, accurate cross sections are used, accounting for the deviation from unity for the refractive index of the medium. For low energies where Bethe-Heitler cross sections are valid, an approximation in the cascade theory was used which results in errors of ~4%. An outline is given of calculations of longitudinal development of ~300 showers in lead, caused by 10^{12}-ev primary electrons and of ~400 showers in a photographic plate, caused by 10^{12}-ev primary photons. The calculated results for the distribution functions are tabulated with reference to the number of particles at a depth t for particles of energy E or energies >E. (B.O.G.)

4501 MONTE CARLO CALCULATION OF 10^{11} TO 10^{13} EV CASCADES TAKING INTO ACCOUNT EFFECT OF MEDIUM ON BREMSSTRAHLUNG. A. A. Varfolomeev and I. A. Svetlolobov. p.277-82 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The calculations of electromagnetic cascades were carried out by the Monte Carlo method using a "Strela" electronic computer. Electrons with energies of $E_0 = 10^9$ to 10^{13} ev were considered as primary electrons. Lateral distributions were not considered because the problem was considered to be unidimensional. The following processes in the nuclear and electronic field of the emulsion components were considered: bremsstrahlung, pair production by quanta and electrons, the Compton effect, photonuclear absorption, and ionization stoppage. The results related to four values of depth: $t_1 = 1.0t_0$; $t_2 = 1.5t_0$; $t_3 = 2.1t_0$; and $t_4 = 2.8t_0$. All the secondary particles (electrons and quanta) with total energy exceeding $\epsilon_1 = 1.5$ Mev for t_1 and t_2 and $\epsilon_2 = 100$ Mev for t_3 and t_4 were traced along the axis of the t-shower. The integral spectrum of pairs produced at depths to t_1 and t_2 for the energy $E_0 = 10^{13}$ ev is shown graphically. It can be seen that in the soft part of the spectrum the number of pairs in the Bethe-Heitler (BH) version is more than twice the number of pairs in the Migdal (M) version. The calculations produced a complete picture of each individual cascade by tracing all the cascade particles from their origin to the maximum depth considered. (B.O.G.)

4502 ELECTRON-PHOTON SHOWERS WITH ENERGIES FROM 10^{11} TO 10^{13} EV IN NUCLEAR EMULSIONS. A. A. Varfolomeev, R. I. Gerasimova, I. I. Gurevich, L. A. Makar'ina, A. S. Romantseva, and S. A. Chueva. p.283-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Recent investigations of electron-photon showers were concerned with the registration of showers with energies of 10^{10} to 10^{12} in nuclear emulsions. The results of an investigation of 15 showers with energies $>10^{11}$ ev at small depths are compared with cascade calculations carried out by the Monte Carlo method. Tabulations are included of general data on the stacks and the location of the shower in the stack; energies determined for 12 of the 15 showers from the electron curves; and the number of electron-positron pairs formed at small distances from the closest electron track. Examinations of graphed data show that if statistical errors are considered, none of the showers investigated can be considered anomalous. In any case, the number of pairs never exceeds, to a perceptible extent, that which can be ascribed to statistical errors. (B.O.G.)

4503 DIRECT PRODUCTION OF ELECTRON-POSITRON PAIRS BY HIGH-ENERGY ELECTRONS. V. A. Tumanian, G. S. Stoliarova, and A. P. Mishakova. p.296-301 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 22830.

4504 ENERGY DETERMINATION OF ELECTROMAGNETIC CASCADES. P. H. Fowler, D. H. Perkins, and K. Pinkau (Univ. of Bristol, Eng.). p.302-5 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Measurement of the number of tracks present at some stage in cascade development is necessary for the determination of energy. Such measurements are made by measuring the attenuation of light in the emulsion by the grains of the cascade tracks. The experimental arrangement of the "densitometer" is given. The results of grain counts are compared with opacity measurements. The slope of the straight line in the resulting graphical comparison determines the effective grain size α ($\alpha = 0.31\ \mu^2$). The distribution of the number of electrons within a given radius are shown graphically including the effect of single and multiple scattering. For distances$\gtrsim$7 radiation lengths from the origin, the lateral distribution cannot be determined with great accuracy with the densitometer. For very flat cascades or for cascades traversing regions of different average radiation lengths a correction to the measurements of

the log of opacity can be estimated by calculating the ratio of the values for rms lateral spread of cascade electrons in a shower that penetrated a homogeneous medium to that in a cascade traversing the regions of different average radiation lengths. (B.O.G.)

4505 AN AIR SHOWER TELESCOPE AND THE DETECTION OF 10^{12} EV PHOTON SOURCES. Giuseppe Cocconi (European Organization for Nuclear Research, Geneva). p.309-11 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A discussion is given concerning the possibility of detecting high-energy photons produced by discrete astronomical objects. It is proposed that the direction of arrival of the photons, relative to the earth, be determined by timing on a horizontal plane the arrival of the air shower (AS) front generated by photons in the atmosphere. The AS detector must be capable of detecting the presence of a point source even when the apparent source position changes because of the earth's rotation. In this sense, the detector must be an AS telescope. The ways in which the tracking can be done by the telescope are described. The possibility of point source detection depends on the signal to background ratio. An estimate of the ratio is made for that energy band in which lie the photons coming from those astronomical objects which are known to emit polarized light. An equation is derived for the rate of arrival of photons of energy U_γ on the earth. Numerical estimates are given for the rate of arrival of 10^{12}-ev photons from the Crab Nebula, the Jet Nebula, and the Sun. (B.O.G.)

4506 THE USE OF THE NEON FLASH TUBE AS A DETECTOR OF IONIZING PARTICLES. G. D. Rochester (Univ. of Durham, Eng.). p.312-15 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The flash tube consists of a glass tube filled with neon and mounted between parallel metal electrodes. The tube flashes if a pulse on the order of 10 kv/cm is applied to the electrodes immediately after an ionizing particle passes through the gas. The internal and layer efficiencies for particle detection are defined. The experimental results are discussed with reference to the dependence of the internal efficiency, η, on neon pressure, the variation of η with the pulse parameters, spurious flashes, the stability of operation and lifetime, and spatial resolutions. When the neon pressure is increased, the efficiency increases, as seen in the graphical representation of the experimental results. The probability of a tube flashing under the action of a random pulse was found to be $\sim 10^{-4}$ for soda-glass. This effect is greater for Pyrex glass than soda-glass. No significant change in the behavior of the tubes was found at 14 to 40°C. Tests with repeated flashing up to 10^8 pulses per tube indicated little deterioration for delay times <40 μsec. High spatial resolution is best obtained by using several staggered layers of tubes to give roughly constant resolution over the angle of acceptance. For five layers of 2.3 π tubes, the uncertainty in location of the particle position is ~0.5 mm. (B.O.G.)

4507 COMPARISON BETWEEN THE RESPONSE OF GEIGER AND SCINTILLATION COUNTERS TO THE AIR SHOWER FLUX. C. S. Wallace (Univ. of Sydney). p.316-18 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

An array of scintillation counters was used to measure the density of particles, particle size, and core location of air showers. In order to find how its response is related to the charged particle density, a tray of Geiger counters was included in the array. A total of 1009 events were recorded in which a reliable estimate of the scintillation particle density near the Geiger tray could be made. These were divided into groups according to shower size and core distance from the tray. Assuming that the ratio B of charged particle density to scintillator density was constant within each group, the values of B were found by maximum likelihood calculations. The dependence of the values of this ratio on both size and radius is discussed. A Monte Carlo calculation was carried out to simulate the energy loss and scattering of electrons traversing the scintillation counter, resulting in that for energies $E \gtrsim 20$ Mev, the energy loss is proportional to E. For $E > 20$ Mev, the energy loss drops increasingly to a limit of 16 Mev. The response from 1-bev stars is estimated as ~200 Mev, giving an average response per 1-bev nucleon of 30 Mev when the response of noninteracting charged nucleons is included. Using this value together with the value 0.4 for B for showers $<2.5 \times 10^6$, a method is described by which the density of 1-bev nucleons in the showers may be determined. For smaller showers, the density is ~30 times that measured by the penetrating particle detectors in the present experiment. The same calculation leads to a value for B of 0.9, which would arise from the electron-photon flux near the core in the presence of nucleons. This estimate of the nuclear density in small showers is approximately equal to the electron density. (B.O.G.)

4508 OBSERVATIONS ON COSMIC RAY PENETRATING SHOWERS AT THE ALTITUDE OF 2000 m ABOVE SEA LEVEL. Z. Sh. Mandzhavidze (Manjavidze), N. N. Roĭnishvili, G. E. Chikovani, A. A. Kozlov, D. M. Kotlarevskiĭ (Kotlarevski), N. G. Tatalashvili, and A. I. Tsintsabadze (Inst. of Physics, Academy of Sciences, Georgian SSR). p.319-22 of Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

A magnetic, double cloud-chamber was used to study the properties of heavy unstable particles. The chamber was operated by penetrating showers generated in a lead absorber above the upper volume of the chamber and in the gap between the upper and lower volumes. Among 8700 nuclear interactions, 139 decays of neutral strange particles and 32 decays of charged particles were observed. As a result of a study of the neutral particles, 45 V^0 tracks were identified as Λ^0-hyperon decays and 38 as θ^0-meson decays. Of 40 V^+ particles, 1 was interpreted as τ-meson decay, 7 fitted the dynamics of K-meson decay, and 2 could be identified only as Σ-hyperons. An investigation was made of the Λ^0 lifetimes in two ways, yielding values of $t_{\Lambda^0} = 2.83^{+1.1}_{-0.6} \times 10^{-10}$ sec and $2.64^{+1.1}_{-0.7} \times 10^{-10}$ sec. The lifetime for all particles was $3.02^{+1.1}_{-0.7} \times 10^{-10}$ sec. A tabulation is given of the $\Sigma^\pm$-hyperon lifetimes with reference to the techniques and methods of measurement. (B.O.G.)

4509 ON THE PARTICLE 550 m_e. T. Yasaki, M. Inoki, M. Machida, and I. Tsushima (Yamanashi Univ., Kofu, Japan). p.323-6 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Preliminary experimental results and tentative interpretations are presented concerning the existence of strange charged particles in soft cosmic rays. An explanation is given of the experimental procedure started to obtain a decisive conclusion about the existence of the 550 m_e particle. The investigation was started to measure the β-decay probability of slow mesons stopped in a 2-mm carbon plate

placed in the middle of a cloud chamber. The measured masses of the particles revealed a significant difference between the results in the soft component and those in the hard component. No appreciable difference between the two components was found when a magnetic cloud chamber was used to determine the particle masses. The particles were separated into groups according to a mass range. The L and H groups, in which the average masses are 86 and 593 m_e, respectively, are free of π and μ mesons, thus implying mesons of a new type. The difference between the mean half life of the strange decaying particle and that of the π meson and μ meson served to certify the existence of the new meson together with the mass of the particle. Alikhanian et al. published results on the mass spectra of charged cosmic particles, and a group of 11 out of 2000 particles were found to lie between 500 and 600 m_e. Keuffel et al. reported a lifetime for such particles at $\sim 10^{-3}$ sec. Basu and Sinha found 5 particles with an average mass of 528 ± 34 m_e and 4 at 280 ± 21 m_e, from a study of μ mesons stopped in a multiplate cloud chamber. (B.O.G.)

4510 ASYMMETRY OF NEUTRONS FROM A μ-MESON REACTION IN LEAD. V. V. Cherdyntsev, L. L. Kashkarov, V. M. Ivanenko, and E. F. Kudashev (Univ. of Kazakhstan, [Japan]). p.327 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

The neutron asymmetry of a (μ^-,n) reaction was studied using cosmic mesons at an altitude of 3850 m. The apparatus consisted of two groups of ten neutron counters immersed in paraffin and separated by a 330-kg lead block. Under the present conditions $\sim 3 \times 10^{-6}$ neutrons were found per second per gram of lead at counting efficiency of ~12%. The experiments showed rising neutrons, i.e., neutrons moving counter to the flow of μ mesons to be predominant. The ratio of the neutrons traveling "upwards" to those traveling "downwards" is 1.186 ± 0.024. The lack of symmetry is clearly evident even when individual measurements are carried out for standard intervals of 100 min. (B.O.G.)

4511 CHANGE OF PROBABILITY OF FAST MESON DECAY CAUSED BY COULOMB SCATTERING IN DENSE MEDIA. M. I. Ryasanov. p.328-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume II. Extensive Air Showers and Cascades Process."

Under decay of fast charged mesons in a dense medium, a part of the impulse may be transferred to atoms of the medium through Coulomb scattering. Such an energy transfer disturbs the kinematics of decay and leads to a change of decay probability. For calculating decay probability in the medium, it is sufficient to substitute in the matrix element normalized wave functions of charged particles in the total outer potential of all atoms of the matter for wave functions of charged particles in vacuum. The expression obtained thus for transition probability should be averaged by all possible arrangements of atoms of the medium. An equation is given for the ratio of the differential decay probabilities in vacuum and in the medium which is independent of spin and rest mass of decaying particles and decay products but is valid only for fast particles. It is noted that by its properties and nature, the effect under consideration is similar to that of Landau-Pomeranchuk for bremsstrahlung. In both cases transition probability changes depend on Coulomb scattering of charged particles on atoms of the medium. The effect under consideration is essentially a quantum effect and cannot be obtained by classical methods. (B.O.G.)

4512 PROCEEDINGS OF THE MOSCOW COSMIC RAY CONFERENCE, JULY 6-11, 1959. VOLUME III. THE EARTH RADIATION BELTS. S. I. Syrovatskiĭ (Syrovatsky), ed. Moscow, International Union of Pure and Applied Physics, 1960. 254p.

Abstracts were prepared for 33 of 40 papers presented in Vol. III of the Proceedings of the Moscow Cosmic Ray Conference. Abstracts had been previously prepared for 6 papers. (C.J.G.)

4513 INVESTIGATION OF RADIATION IN OUTER SPACE. S. N. Vernov and A. E. Chudakov. p.19-29 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Experimental data obtained by the 2nd and 3rd Sputniks and the Soviet cosmic rocket on cosmic radiation at 250 to 2000 km over a wide range of latitudes and longitudes is presented. Data concerning the outer radiation zone, inner zone, and radiation external to the magnetic field of the earth are discussed relative to location, particle composition, and intensity stability. (C.J.G.)

4514 MAGNETIC FIELD OF THE OUTER CORPUSCULAR REGION. S. Sh. Dolginov and N. V. Pushkov. p.30-1 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

The corpuscular region of the magnetic field of the earth was determined to have two field intensity maxima of 800 and 200 gammas at 20,000 and 23,000 km from the center of the earth, respectively. (C.J.G.)

4515 ALTITUDE DEPENDENCE AND TIME VARIATION OF THE RADIATION INTENSITY OBSERVED BY U.S. SATELLITE 1958 α. Y. Miyazaki and H. Takeuchi (Inst. of Physical and Chemical Research, Tokyo). p.41-5 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Data obtained from Explorer I on the altitude dependence and time variation of the radiation intensity at 340 to 1200 km altitude are presented. (C.J.G.)

4516 COMPOSITION OF THE EARTH'S CORPUSCULAR RADIATION AND POSSIBLE MECHANISMS OF ITS ORIGINATION. S. N. Vernov, A. E. Chudakov, A. I. Lebedinskiĭ (Lebedinsky), and I. P. Ivanenko. p.46-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

The composition of the Van Allen radiation belts is given. In the external zone, limited by magnetic lines of force at geomagnetic latitudes of 55 and 65°, the majority of particles were found to be electrons of 20 to 100 kev. Magnetic energy density in this area is 10^{-6} erg/cm^3. In the internal zone, limited by magnetic lines of force at geomagnetic latitudes of 30 to 40°, protons of ~100 Mev were found. The origin of the corpuscular radiation is proposed to be from the decay of neutrons emitted by the atmosphere of the earth as a result of cosmic-ray irradiation. Several hypotheses are introduced in an attempt to account for proton losses above the geomagnetic latitude of 30° (excluding ionization losses). (C.J.G.)

4517 THE NATURE AND ORIGIN OF THE EARTH'S RADIATION BELTS. THEIR RELATION TO UPPER ATMOSPHERE DENSITIES AND THEIR GEOPHYSICAL EFFECTS. S. F. Singer (Univ. of Maryland, College Park). p.50-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

The origin of the radiation belts of the earth is discussed relative to neutral particle and hydrogen ion density in the upper atmosphere. These densities are calculated for the cosmic, auroral, and magnetic storm belts. The geophysical effects of the radiation belts are discussed. (C.J.G.)

4518 ON FAST CORPUSCULES OF THE UPPER ATMOSPHERE. V. I. Krassovskiĭ (Krassovsky), I. S. Shklovskiĭ (Shklovsky), G. I. Galperin, and E. M. Svetlitskiĭ (Svetlitsky). p.59-63 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Fluxes of electrons of ~10 kev were detected by fluorescent screens of ZnS activated with silver at altitudes of 470 to 1880 km above sea level. The equivalent energy of the electrons was ~20 kev and their minimum current was estimated as 10^{-14} A cm^{-2} steradian^{-1} at night above the geomagnetic equator. At middle and polar latitudes up to 60° of geomagnetic latitude, a current of 5.10^{-11} A cm^{-2} steradian^{-1} was found for electrons of the equivalent energy of 12 kev. (C.J.G.)

4519 ON THE PROBLEM OF THE NATURE OF SOFT RADIATION IN THE UPPER ATMOSPHERE. L. I. Dorman. p.74-80 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

The properties and origin of soft cosmic-ray bursts in the stratosphere are discussed and compared to similar processes on the sun, in corpuscular streams, in the interplanetary medium, and to the properties of the radiation belts of the earth. (C.J.G.)

4520 ON THE NATURE OF THE EXTERNAL RADIATION BELT OF THE EARTH. G. Askaryan. p.81-2 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

An explanation is offered for the origin of the external radiation belt encircling the earth. It is proposed that plasma streams from the surface of the sun are reflected from and flow around the magnetic field of the earth. The plasma stream penetrates into the magnetic field until the diamagnetic repulsive force acting on it retards the translational motion of the ionic fraction of the plasma stream. (C.J.G.)

4521 OBSERVATIONS ON THE HELIUM NUCLEI OF THE COSMIC RADIATION. P. J. Duke (Univ. of Bristol, Eng.). p.89-91 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Data on the total flux of primary cosmic-ray α particles and their differential energy spectrum below 1000 Mev/nucleon were determined at 117,000 ft at a geomagnetic latitude of $\lambda = 55°$N. These data are correlated with a large increase in solar activity observed during the same period (July 1955 to 1957). (C.J.G.)

4522 OBSERVATION ON THE HEAVY NUCLEI OF THE COSMIC RADIATION AT VERY LOW ENERGIES. David Evans (Univ. of Bristol, Eng.). p.92-5 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Data are presented on the heavy nuclei of cosmic radiation at very low energies at sea level which indicate that intensity is inversely correlated with sunspot number. (C.J.G.)

4523 THE INTERACTION OF VERY HEAVY COSMIC RAY NUCLEI. C. J. Waddington (Univ. of Bristol, Eng.). p.112-14 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

An attempt is made to modify the diffusion model for cosmic heavy nuclei ($Z \geq 10$) propagation through the atmosphere by breaking the H group up into H-nuclei ($10 \leq Z \leq 19$) and VH-nuclei ($Z \geq 20$). Experimental data suggest that the ratio of the fluxes at the top of the atmosphere should have a value of $J_H0/J_M0 \leq 0.20$. (C.J.G.)

4524 INTENSITY OF PRIMARY HELIUM AT GEOMAGNETIC LATITUDE 3°N. B. Hildebrand, F. W. O'Dell, M. M. Shapiro, and B. Stiller (U. S. Naval Research Lab., Washington, D. C.). p.115-17 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

A primary helium flux of 15.7 ± 2.2 peters was observed at an altitude of 103,000 ft at geomagnetic latitude 3°N. The data revealed no effect of the solar cycle on the equatorial flux of primary helium. (C.J.G.)

4525 ABUNDANCE RATIO OF LITHIUM, BERYLLIUM AND BORON TO THE HEAVIER PRIMARY NUCLEI IN THE COSMIC RADIATION. F. W. O'Dell, M. M. Shapiro, and B. Stiller (U. S. Naval Research Lab., Washington, D. C.). p.118-22 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Preliminary results from an experiment designed to measure the abundance ratio of lithium, beryllium, and boron to the heavier primary cosmic nuclei yield a value of 0.27 ± 0.06. The data were taken at an atmospheric depth of 2.7 gm/cm^2. (C.J.G.)

4526 INVESTIGATIONS OF HIGH-ENERGY HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION CLOSE TO THE GEOMAGNETIC EQUATOR (GUAM, MARIANAS ISLANDS). D. M. Haskin, P. L. Jain, E. Lohrmann, Marcel Schein, and M. Teucher. p.123-4 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

The energy spectrum of heavy nuclei in primary cosmic radiation was determined at 7 to 100 Bev/n at the geomagnetic equator. The 540 tracks of high-energy heavy nuclei were analyzed to determine interaction mean free paths, fragmentation probabilities, and meson production. (C.J.G.)

4527 ON THE CHARGE SPECTRUM OF HEAVY PRIMARIES. B. Waldeskog, O. Mathiesen, and K. Kristiansson (Univ. of Lund, Sweden). p.125-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

The charge spectrum of 150 tracks of heavy nuclei of primary cosmic radiation is analyzed. (C.J.G.)

4528 ENERGY SPECTRUM OF PRIMARY COSMIC PARTICLES. A. N. Charakhchohyan and T. N. Charakhchyan (Lebedev Inst. of Physics, [Moscow] and Moscow [State] Univ.). p.129-35 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

The energy spectrum of primary cosmic particles was determined at geomagnetic latitudes of 51, 31, and 2°. (C.J.G.)

4529 OBSERVATION OF THE POINT SOURCE OF COSMIC RAYS. Y. Sekido, S. Yoshida, Y. Kamiya, H. Ueno, and T. Murayama (Nagoya Univ., Japan). p.137-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Possible positions for the point source of cosmic rays are given. A correction for the geomagnetic deflection is employed. (C.J.G.)

4530 THE POINT SOURCE OF COSMIC RAYS AND A VARIABLE STAR "W-ORIONIS." T. Murayama (Nagoya Univ., Japan). p.140-2 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Sekido et al. determined a point source of high-energy cosmic rays by assuming that the observed cosmic rays are produced by the collision of air nuclei with the high-energy γ rays incident on the earth. The cosmic-ray intensity of the point source of Sekido showed time variation, indicating a variable celestial body. Sekido estimated the direction of the γ rays outside the atmosphere of the earth to be $\alpha = 4^h57^m \pm 5^m$, $\delta = 1.5°N \pm 1.5°$. Among several variable stars in the neighborhood of the above mentioned position, the star "W-ORIONIS" is examined as the point source emitting high-energy γ rays for the production of cosmic rays. (C.J.G.)

4531 ABSENCE OF SOLAR AND SIDEREAL TIME VARIATIONS OF EAS DURING 1958. J. Delvaille, F. Kendziorski, and K. Greisen (Cornell Univ., Ithaca, N. Y.). p.143-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

The absence of solar and sidereal time variations of extensive air showers during 1958 was investigated in an attempt to find a consistent relation among the apparent time variations of high-energy primary cosmic rays previously reported. The Fourier components of cosmic electron showers of 10^4 to 1.5×10^7 electrons are given in solar, sidereal, and antisidereal time. (C.J.G.)

4532 AN EXPERIMENT FOR MEASURING THE CHEMICAL COMPOSITION OF PRIMARIES IN THE AIR SHOWER REGION. G. T. Murthy, B. Peters, P. V. Ramanamurthy, and B. V. Shreekantan (Tata Inst. for Fundamental Research, Bombay). p.150-2 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

An experiment for measuring the chemical composition of cosmic-ray primaries in the airshower region is described. An apparatus, of which the most important component is two large spark counters in coincidence, to detect high-energy nucleons in the presence of electrons is described. The chemical composition of the primaries is determined as a function of energy per nucleon and total energy. (C.J.G.)

4533 PRIMARY ENERGY SPECTRUM AND AIR-SHOWERS. B. Peters (Univ. Inst. for Theoretical Physics, Copenhagen). p.157-66 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

An attempt is made to show that a cut-off exists in the primary cosmic-ray spectrum at a magnetic rigidity corresponding to that of protons with about 10^{15} ev. The effects that such a cut-off would have on observable quantities in the airshower region are approximated and discussed. (C.J.G.)

4534 PROCESSES INVOLVED IN ELECTROMAGNETIC ACCELERATION OF PARTICLES TO COSMIC-RAY ENERGIES. W. F. G. Swann (Bartol Research Foundation, Philadelphia). p.167-70 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

A method for accelerating particles to cosmic-ray energies by electromagnetic induction coupled with changing magnetic fields (betatron action) is discussed. (C.J.G.)

4535 CHEMICAL COMPOSITION OF COSMIC RAYS AND ORIGIN OF ELEMENTS. S. Hayakawa, C. Hayashi, K. Ito, J. Jugaku, M. Nishida, and N. Ohyama (Kyoto Univ.). p.171-80 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

An attempt is made to explain the relative abundances of elements in cosmic rays in terms of the rapid process that is supposed to take place in the earliest stage of the supernova explosion. The process of building up the α-particle nuclei and taking the chain of (p,γ) and (α,p) or (α,n) reactions into account is discussed. The cycling reactions of the rapid CNO cycle are considered. The occurrence of a burning front that expands rapidly from nuclear reactions occurring in the CNO cycle is hypothesized. The origin of Li, Be, B, and D by cosmic-ray bombardment of heavier nuclei on stellar surfaces is discussed. (C.J.G.)

4536 INTERPRETATION OF THE ENERGY SPECTRA OF HEAVY PRIMARY COSMIC RAYS. S. Hayakawa, M. Koshiba, and Y. Terashima (Kyoto Univ.). p.181-92 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Previously reported data show that the rigidity spectra of various cosmic heavy nuclei have essentially the same shape with a maximum at about 2.2 Bev. Since the shapes of the energy spectra of different nuclei were essentially the same, various localized sources could be expected. No indication of multiple sources was found. To account for this discrepancy, three possibilities are considered: (1) effectiveness of interstellar acceleration, (2) the substantial contribution of only a single kind of sources to the observed cosmic rays, or (3) effects of solar modulation on the spectra at low energies. Possible local sources that could be responsible for shaping the spectrum at low energies are examined relative to a magnetic-mirror model and a model based on the expanding shell of the Crab nebula. (C.J.G.)

4537 SOME ASPECTS OF THEORY OF COSMIC RAY ORIGIN. V. L. Ginzburg (Lebedev Inst. of Physics, [Moscow]). p.196-204 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Aspects of the theory of cosmic-ray origin are briefly discussed. These aspects include the following: (1) mean gas concentration of the galaxy; (2) injection and particle acceleration mechanism of cosmic-ray sources, excepting supernovae and novae; (3) escape of cosmic rays from galactic halo into intergalactic space; (4) cosmic-ray movement in the galactic spiral; and (5) origin of the cosmic-ray electron component in the halo. 31 references. (C.J.G.)

4538 ACHIEVEMENTS IN RADIOASTRONOMY AND RADIOASTRONOMICAL THEORY OF THE ORIGIN OF COSMIC RAYS. I. S. Shklovskiĭ (Shklovsky). p.205-10 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

The radioastronomical theory of the origin of cosmic rays is discussed relative to developments in radioastronomy. The sources of galactic synchrotron radiation are described. The quantity of relativistic electrons generated during the explosions of supernovae of Class II is estimated. The generation of relativistic particles by explosions of supernovae of Class I is discussed. (C.J.G.)

4539 ON THE COMPOSITION OF PRIMARY COSMIC RAYS. A. A. Korchak and S. I. Syrovatskiĭ (Syrovatsky). p.211-19 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

An explanation of the origin of cosmic rays is made difficult by the composition of cosmic radiation that is characterized by an excess of heavy nuclei. An analysis of this problem showed that apparently only heavy nuclei are accelerated in the source and the composition observed near the earth results from the process of heavy nuclei fragmentation in interstellar gas. (C.J.G.)

4540 ON THE DIFFUSION OF COSMIC RAYS IN THE GALAXY. Leverett Davis, Jr. (California Inst. of Tech., Pasadena). p.220-5 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Several models concerning the storage of cosmic rays in the galaxy, which have been used to determine the amount of matter that cosmic rays traverse between their acceleration to relativistic velocity and their arrival at the top of the atmosphere, are examined. The models considered include the following: Model I, in which all particles pass through the same amount of interstellar material; Model II, in which the particles undergo a steady-state diffusion by three dimension random walk from a point source in an infinite medium of constant density; Model III, which is the same as Model II except for a perfect reflecting boundary, taken to be the radius of the galactic halo; and Model IV, which is a steady-state model with uniform injection throughout the volume, rapid diffusion, and slow leakage at the surface. (C.J.G.)

4541 A POSSIBLE SOLAR PARTICLE ACCELERATION MECHANISM. Leverett Davis, Jr. (California Inst. of Tech., Pasadena). p.226-7 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

A solar particle acceleration mechanism, based on a modification of the Fermi acceleration mechanism, is described. A high-velocity ion is considered to be spiraling along a magnetic tube of force that rises in an arch through the corona with both ends reaching down through the photosphere. This ion will be reflected from regions of increasing field strength as it moves up at each helix angle of the arch, provided the helix angle is not too small. No mechanism is proposed for escape of the highly accelerated ions from the confining tube of force. (C.J.G.)

4542 ON THE ACCELERATION OF COSMIC RAYS DURING THE EARLY PART OF THE EVOLUTION OF OUR GALAXY. L. Biermann (Max-Planck-Institut für Physik und Astrophysik, Munich) and Leverett Davis, Jr. p.228-32 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

A hypothesis is presented which states that cosmic rays were accelerated to relativistic velocities early in the evolution of the galaxy when its properties were not such as they are today. These earlier properties must have included the following: a large storage column with little leakage, a low-density halo, a ratio of light to heavy cosmic nuclei at the top of the atmosphere of ≤ 0.25, and initial acceleration occurring after a reasonable amount of heavy-element formation with preferential acceleration of heavy elements. Abundance ratios of cosmic nuclei are given and used to estimate the amount of material traversed by the cosmic rays in accelerating to relativistic energies. The age of cosmic rays is estimated. The effect of the galaxy disk on the fragmentation of cosmic rays is estimated. (C.J.G.)

4543 POSSIBLE ACCELERATION OF CHARGES BY THE ELECTROMAGNETIC FIELD OF THE MAGNETIC DIPOLE OF THE EARTH. Y. P. Terletskiĭ (Terletsky). p.233-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Calculations were made of the electromagnetic field in the neighborhood of the rotating magnetic dipole of the earth. Equations are presented which describe the motion of charges in this field. (C.J.G.)

4544 ON THE INITIAL STAGE OF CHARGED-PARTICLE ACCELERATION. L. I. Dorman. p.239-44 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume III. The Earth Radiation Belts."

Calculations were made of the injection energy in a solar flare relative to charged-particle acceleration by the Fermi statistical mechanism. The acceleration of particles from the medium between approaching magnetic clouds is calculated for both relativistic and nonrelativistic cases. Charged-particle acceleration from very low energies to relativistic energies is computed. The problem of particle injection for acceleration in a magnetic trap is discussed relative to the cases of particle acceleration in a solar flare, between clouds in the interplanetary medium, and in interstellar space. (C.J.G.)

4545 PROCEEDINGS OF THE MOSCOW COSMIC RAY CONFERENCE, JULY 6-11, 1959. VOLUME IV. VARIATIONS OF COSMIC-RAY INTENSITY. L. I. Dorman and V. F. Tulinov, eds. Moscow, International Union of Pure and Applied Physics, 1960. 366p.

Fifty-two papers and two summaries of papers are included on variations of cosmic-ray intensity. Forty-five papers are covered by separate abstracts. Seven papers were previously abstracted in NSA. (M.C.G.)

4546 INTENSITY VARIATIONS OF COSMIC RAYS. L. I. Dorman. p.7-17 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

Composite measurements made of variations of the different components of cosmic rays are discussed. The observed intensity of any one secondary component is determined by three factors: the geomagnetic threshold; the integral multiplicity which shows the number of secondary particles recorded by a given instrument from a single primary particle of specific energy; and the energy spectrum of the primary particles. Data on long-period variations in cosmic-ray intensity and the knee shift of the latitude effect are summarized. Studies of the effects of magnetic storms on cosmic rays are discussed. Extensive experimental material which confirmed and extended information on 27-day variations is also discussed. A general picture of cosmic-ray modulation in the solar system is presented. (M.C.G.)

4547 ON THE QUESTION OF A UNIFIED PROCEDURE FOR INTRODUCING CORRECTIONS FOR METEOROLOGICAL EFFECTS INTO DATA OBTAINED BY MEANS OF MESON TELESCOPES AND IONIZATION CHAMBERS. L. I. Dorman. p.21-4 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The problem of developing a unified procedure for introducing corrections for meteorological effects into data observed by means of meson telescopes and ionization

chambers is discussed. Exponential equations are used to introduce corrections for barometric effects. The difference between the mass of the column of air above the apparatus and the barograph readings must be allowed for in the corrections. Two methods are in use for temperature corrections. The empirical method encounters fundamental and insurmountable difficulties associated with the specificity of the terrestrial atmosphere. For this reason it is believed that this method cannot serve as the basis for a unified procedure. The theoretical or integral method, as explained, can, apparently, serve as the basis for a unified procedure. (M.C.G.)

4548 ON THE CORRECTION MESON INTENSITIES FOR ATMOSPHERIC TEMPERATURES. A. Ehmert. p.25-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

An equation was derived for correcting meson intensities for atmospheric temperatures. The real absorption influence of air pressure and the influence of decay in the proximity of the station are taken into account. (M.C.G.)

4549 ATMOSPHERIC COEFFICIENTS AND SOLAR DAILY VARIATION OF THE COSMIC RADIATION MEASURED 18 m UNDERGROUND. T. Sandor, A. Somogyi, and F. Telbisz (Central Research Inst. of Physics, Hungarian Academy of Sciences, Budapest). p.30-4 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The intensity variations of cosmic radiation at a depth of 18 m underground in Budapest, Hungary, was determined. The total barometric coefficient, the absorption coefficient, and the decay coefficient were first calculated. After the data for absorption and decay effects were corrected, the amplitude and phase of the solar daily variation for each monthly period from Mar. 1958 to Mar. 1959 were determined. The results are tabulated. (M.C.G.)

4550 ANNUAL VARIATIONS OF COSMIC-RAY INTENSITY, AND TEMPERATURE CORRECTIONS. E. S. Glokova. p.35-6 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

After temperature corrections were introduced into mean-monthly values of cosmic-ray intensity in Moscow, Ykautsk, and Cheltenham, a regular seasonal wave with a summer maximum was found in the data for Moscow and Yakutsk. In Cheltenham no marked reverse seasonal wave was apparent. (M.C.G.)

4551 ON THE METEOROLOGICAL EFFECTS OF THE SOFT COMPONENT OF COSMIC RADIATION. Ya. L. Blokh. p.37-40 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The theory of atmospheric effects on the soft component of cosmic radiation is verified. The soft component, measured in Moscow during the period July 1957 to February 1959, consisted of 90.5% electrons, 8.5% soft μ-mesons, and 1% nucleons. With the use of this composition, a general expression was obtained for the atmospheric variations of the soft component in semicubic geometry. The barometric coefficient was found to be 0.34%/mb. The temperature coefficient was determined as +0.16%/°C. These values were in good agreement with experimental results. (M.C.G.)

4552 ON THE THEORY OF SECOND-ORDER METEOROLOGICAL EFFECTS OF COSMIC RADIATION. L. I. Dorman. p.41-3 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The recorded intensity of the secondary component of cosmic radiation was found to depend on the state of the atmosphere over the apparatus. This in turn is determined by the pressure and temperature distributions throughout the atmosphere. Equations were derived to correct data for these effects. (M.C.G.)

4553 ON THE VARIABILITY OF THE METEOROLOGICAL COEFFICIENTS OF THE HARD COMPONENT OF COSMIC RADIATION. N. S. Kaminer. p.44-6 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The results of calculations of the dependence of barometric and temperature coefficients of the hard components of cosmic radiation on the shield thickness above the instrument, on the altitude of the station above sea level, and on the temperature of the atmosphere for particles incident vertically are given. The calculations were carried out on the basis of approximate equations which gave sufficiently good comparisons with experimental results. (M.C.G.)

4554 ON THE RELATIONSHIP BETWEEN THE PRIMARY AND SECONDARY COMPONENTS OF COSMIC RADIATION. A. I. Kuzmin. p.48-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The coupling coefficients of the primary and secondary components of cosmic radiation were determined on the assumption that, on the average, the ratio $\alpha = E/E\mu$ exists between the energy E of the primary particle and the energy $E\mu$ of the generated μ-meson. Graphs of the results are included. (M.C.G.)

4555 STUDIES OF INTENSITY VARIATIONS OF COSMIC RADIATION IN THE STRATOSPHERE. S. N. Vernov, B. E. Samosudov, V. F. Tulinov, A. N. Charakhchyan, and T. N. Charakhchyan. p.53-64 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

Measurements in the stratosphere yielded data on secular, 27-day intensity variations of cosmic radiation and on cosmic-ray variations that occur during very large magnetic storms. An interesting effect observed at great altitudes was detected. During intensity increases of cosmic radiation in northern latitudes (64°), at lower latitudes (51°) the reverse was observed. (auth)

4556 BALLOON FLIGHT INVESTIGATIONS OF PRIMARY COSMIC RAYS DURING SOLAR DISTURBANCES. M. A. Pomerantz, S. P. Agarwal, and V. R. Potnis (Bartol Research Foundation, Swarthmore, Penna.). p.65-73 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

An extensive series of balloon flights was conducted during the peak of the present solar maximum; instruments identical with those flown previously during the declining portion of the preceding solar cycle (1949 to 1952) were used. During the interval from July 1957 to Sept. 1958, no sporadic increases in intensity were detected at Swarthmore, Pa., by quadruple coincidence-counter trains containing 86 g/cm^2 of absorber. In eight cases, solar flares of importance 2 or greater occurred while the instruments were aloft, and on one occasion (Aug. 22, 1958) a large in-

crease in the flux of low-energy cosmic rays was observed at balloon altitudes elsewhere. A recurrence tendency with a periodicity of 28 ± 1 days was followed for about 5 months. The fluctuations in the counting rates of the balloon-borne instruments were correlated with those observed by ground-based neutron monitors, and the mean factor relating the relative changes is 1.6 ± 0.3. However, it is unlikely that this ratio remains constant. (auth)

4557 THE EFFECT OF DIMINISHING SOLAR ACTIVITY AND COSMIC-RAY INTENSITY FROM MEASUREMENTS IN THE STRATOSPHERE. Yu. G. Shafer. p.74-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

An investigation was made of the intensity variations of cosmic radiation in the stratosphere as a function of the cycle of solar activity. An increase in intensity in the stratosphere due to an additional stream of particles of low energy was noted during the period of depressed solar activity. This variation of the primary radiation was not accompanied by significant transformation of the energy spectrum and was due to the scattering of homogeneous magnetic fields. (M.C.G.)

4558 BALLOON MEASUREMENTS ON TIME VARIATIONS OF PRIMARY COSMIC RADIATION. A. Ehmert and H. Erbe (Max-Planck-Institut für Aeronomie Lindau, Gottingen, Ger.). p. 80-4 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

To study the relationship of primary cosmic-radiation variations to the variations of the steadily recorded secondary components, a number of balloon measurements were made at widely different ground-level intensities. It was found that a 1% change in the number of primaries at 49° geomagnetic latitude induced a change of 0.46% in the number of neutrons and a 0.22% change in the number of mesons at ground level. The electric-field deceleration hypothesis was confirmed. (M.C.G.)

4559 TWO UNUSUAL EVENTS AT HIGH ALTITUDES. H. V. Neher and Hugh R. Anderson (California Inst. of Tech., Pasadena). p.101-3 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

Two unusual increases in ionizing radiation were observed at balloon altitudes at Bismarck, N. D. The first occurred on July 28, 1954. The radiation had higher energy and was not geomagnetic-field limited but was probably due to protons down to energies of 100 Mev. The second event, a sudden burst of radiation that lasted for about 15 min, took place on Oct. 16, 1958. These sudden increases were not of the solar-flare type and did not seem to be accompanied by any appreciable ionospheric or magnetic disturbance. (M.C.G.)

4560 THE KNEE OF THE LATITUDE CURVE AT BALLOON ALTITUDES. H. V. Neher and Hugh R. Anderson (California Inst. of Tech., Pasadena). p.104-7 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The knee in the latitude curve of cosmic-ray intensity was investigated in the northern and southern hemispheres. The latitude at which the knee occurs is defined as that latitude at which the intersection of the best straight lines that can be drawn through the curves on each side of the knee occurs. By application of this definition to the data obtained in the northern hemisphere near 100°W longitude, it was found that the knee occurred at 53.4°N in the summer of 1958. Data from the southern hemisphere showed that the knee was at 53.1°S in the region of 180° longitude. (M.C.G.)

4561 ON THE CHARACTER OF COSMIC-RAY INTENSITY VARIATIONS DURING MAGNETIC STORMS. L. I. Dorman. p.111-27 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

In an investigation of Forbush type depression profiles of cosmic-ray intensity during magnetic storms, an attempt was made to give more precise calculations by means of coupling coefficients. In addition, a study was made of the problem of the possible effect of inhomogeneity of the magnetic field in a stream and of other subsidiary modulations of intensity on the observed profiles of cosmic-ray variations during magnetic storms. The theory that the principal peculiarities of the variation profile during magnetic storms is connected, chiefly, not with peculiarities of individual streams, but with the different ways in which the earth enters a corpuscular stream carrying a frozen-in magnetic field is discussed. (M.C.G.)

4562 ON THE COSMIC RAY STORMS DUE TO THE SOLAR CORPUSCULAR STREAMS. Masatoshi Kitamura (Meteorological Research Inst., Tokyo). p.128-33 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The diffusion mechanism of the primary cosmic-ray particles into the magnetic clouds emitted from the sun, in which the disordered magnetic field is frozen, is discussed. The propagation process of cosmic-ray particles into the magnetic cloud was treated by a diffusion equation. It is shown that the result of calculation of the cosmic-ray decrease on the earth as a function of geomagnetic latitude is in fairly good agreement with observed-latitude effect of Forbush type decrease when the scattering length, l, of the cosmic-ray particles in the magnetic clouds is proportional to $E^{0.2}$, where E denotes the energy of the particle. (auth)

4563 ON THE ENERGY SPECTRUM AND DURATION, ON EARTH, OF A COSMIC-RAY INTENSITY INCREASE CAUSED BY A SHOCK WAVE AND ALBEDO FROM THE FRONT MAGNETIZED FACE OF A CORPUSCULAR STREAM. L. I. Dorman. p.134-41 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959, Volume IV. Variations of Cosmic-Ray Intensity."

A slight increase in cosmic-ray intensity was noted a few hours before the commencement of the magnetic storm of Aug. 29, 1957. The view that the observed intensity increase was due to a shock wave from the sharp front face of the corpuscular stream carrying a frozen-in magnetic field is discussed. The primary-variation energy spectrum produced by a shock wave is evaluated. It was found that the shock wave could yield a noticeable increase of a few per cent not only in the neutron component but in the hard component at sea level at medium latitudes and at the equator. (M.C.G.)

4564 ON THE MODULATION OF THE PRIMARY COSMIC RAY SPECTRUM BY SOLAR ACTIVITY. A. Ehmert (Max-Planck-Institut für Aeronomie Lindau, Gottingen, Ger.). p.142-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

An experimentally determined formula on the distribu-

tion of the amolitudes of world-wide variations is shown to agree with the electric-field-modulation hypothesis. Full agreement with the experimental distribution was obtained by extrapolating the high-energy distribution of primaries and calculating its deformation by electric-field deceleration. A deceleration potential of ~1 Gv even in sunspot minimum increased by 0.8 Gv from 1954 to the end of 1957. The most severe Forbush decreases during magnetic storms needed an augmentation of the deceleration field by ~1 Gv within a few hours. A diminution of the ionization at Huancayo by 0.62% corresponded to an increase of the earth's electric potential by 10^8 volts. The possibility of a circumsolar electric field is discussed. (auth)

4565 INTENSITY VARIATION OF THE TOTAL COMPONENT IN ROME, FROM 1954 TO 1957. F. Bachelet, A. M. Conforto, and N. Iucca (Università, Rome). p.153-4 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The total ionizing component of cosmic radiation at sea level was measured in Rome from Apr. 1954 to June 1957. The percentage variations of the corrected monthly means are shown for the Rome data along with corresponding values obtained for the meson component at other stations. (M.C.G.)

4566 DETERMINING THE CHARACTER OF EARTH-ENVELOPMENT BY A STREAM, AND THE PROPERTIES OF CORPUSCULAR STREAMS FROM COSMIC-RAY VARIATIONS DURING DIFFERENT MAGNETIC STORMS. Ya. L. Blokh, L. I. Dorman, and N. S. Kaminer. p.155-66 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The intensity variations of the hard and neutron components of cosmic radiation during magnetic storms covering the period 1954 to 1958 were investigated. For each case the appropriate profile of intensity variation of cosmic radiation was found and compared with the theoretically accepted value. It was assumed that the profile of cosmic-ray intensity variations during magnetic storms is totally determined by how the earth enters the corpuscular streams carrying frozen magnetic fields, by the velocity of the stream, and by the distribution of the field in the stream. It was found that two types of streams exist: long-lived broad streams with small fields that envelop the earth with their side edges and narrow short-lived streams with large fields. For each case studied the energy spectra of the variations were found. Graphs of the results are included. (M.C.G.)

4567 ELECTROMAGNETIC CONDITIONS IN INTERPLANETARY SPACE ACCORDING TO THE DATA OF COSMIC-RAY VARIATIONS DURING THE PERIOD FROM AUGUST 20 TO SEPTEMBER 10, 1957. Ya. L. Blokh, E. S. Glokova, L. I. Dorman, and O. I. Inozemtseva. p.167-72 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The properties of the corpuscular streams that caused cosmic-ray intensity variations during the period August 29, to September 10, 1957, were determined. Inside the broad corpuscular stream that enveloped the earth with its side part, there were several narrower streams emitted that enveloped the earth with their front faces and produced sharp depressions in the intensity of cosmic radiation. The variations measured were the result of the mutual superposition of the action of different streams. (M.C.G.)

4568 THE EFFECT OF INTENSITY-INCREASE OF COSMIC RADIATION PRIOR TO MAGNETIC STORMS. Ya. L. Blokh, L. I. Dorman, and N. S. Kaminer. p.173-90 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

An analysis of the increase in cosmic-ray intensity before the magnetic storm of July 8, 1958, showed that this increase was due chiefly to the acceleration of particles in their reflection from the magnetized front face of the corpuscular stream. The energy spectrum obtained on the basis of stream parameters found from the nature of the intensity variations agreed with experimental data. An analysis of the intensity increase before the magnetic storm of August 29, 1957, showed the same mechanism. Not a single magnetic storm of the type in which the earth is enveloped by the magnetized leading part of the stream gave rise to a noticeable intensity increase. Almost all magnetic storms of the type in which the earth is enveloped by the front magnetized face of the stream gave rise to a noticeable intensity increase. (M.C.G.)

4569 LOCAL AND WORLDWIDE CR INTENSITY VARIATIONS DURING GEOMAGNETIC STORMS AND SMALL GEOMAGNETIC DISTURBANCES. R. L. Chasson and K. Maeda (Univ. of Nebraska, Lincoln). p.191-6 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

A detailed search was made for anomalous behavior in cosmic-ray intensity variations, both local and worldwide. The general and specific structure of the intensity fluctuations during geomagnetic storms and Forbush decreases was also investigated. In the world-wide studies from July 1, 1957, to April 30, 1958, the measurements were carried out at three stations in the 50°N latitude belt. A study was made of the intensity trends for the stations. Characteristics of the recurrence phenomenon for effective geomagnetic storms included calm surrounding the zero epoch, postcommencement surge periodicity of $1\frac{1}{2}$ hr, and the independent confirmation of cosmic-ray trends between sudden and gradual commencement storms. (M.C.G.)

4570 STUDY OF THE COSMIC-RAY STORM BY JAPANESE GROUP. Y. Sekido (Nagoya Univ., Japan). p.197-8 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

After an analysis of data, it was decided that the cosmic-ray storm is caused by a magnetic cloud emitted by the solar flare associated with the type IV solar radio outburst. The magnetic field of this cloud is sufficient to cause a world-wide cosmic-ray decrease, but the process responsible for this modulation is not known. (M.C.G.)

4571 COSMIC-RAY STORMS AND SOLAR RADIO EMISSIONS. Yoshiko Kamiya (Nagoya Univ., Japan) and Masami Wada. p.199-201 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The results of investigation into the relation between cosmic-ray storms and solar radio outbursts are presented. The study was restricted within the data obtained during the IGY period from July 1957 to December 1958. It was found that every cosmic-ray storm occurred after a solar flare accompanied by a radio outburst of type IV; the cosmic-ray decrease was nearly independent of meredian distance where respective outburst occurs; and solar

corpuscular clouds, that contribute to the cosmic-ray storms may be emitted just on the occasion of type IV outbursts. (auth)

4572 TIME VARIATION OF THE ENERGY SPECTRUM OF COSMIC RAY PARTICLES DURING THE FORBUSH-TYPE DECREASE. M. Kitamura (Meteorological Research Inst., Tokyo) and M. Kodama. p.202-7 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The latitude effect of the Forbush decreases of the cosmic-ray intensity was analyzed by using the world-wide IGY data in order to study the time variation of the energy spectra during the cosmic-ray storms. It was found from this analysis that the energy E^x, above which higher-energy particles of the primary cosmic rays do not display the intensity decrease during the cosmic-ray storms, shifts toward the higher-energy side with the development of the cosmic-ray storms and then toward the lower-energy side with the recovery of the intensity decreases. It is suggested that the energy spectrum in the lower-energy part changes to become flatter in the mature stage than that in other stages. These features may be explained by the model that the Forbush-type decreases take place due to the diffusion of the cosmic particles into the magnetic clouds emitted from the sun, containing the disordered magnetic field. Furthermore, it is shown that decreases in cosmic particles of low energy recover more slowly than those of high energy. This fact is favorable to the diffusion model on the cosmic-ray storm. (auth)

4573 ON WORLDWIDE COSMIC-RAY INTENSITY INCREASES ASSOCIATED WITH COSMIC-RAY STORMS. I. Kondō, K. Nagashima, S. Yoshida, and M. Wada (Nagoya Univ., Japan and Inst. of Physical and Chemical Research, Tokyo). p.208-15 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The dependence of world-wide cosmic radiation intensity increases associated with magnetic storms on latitude, longitude, altitude, and composition was investigated in order to determine the cause of the increase. The intensity variations observed by neutron monitors for the periods September 11 to 15, 1957, and February 9 to 13, 1958, were studied because of the marked increase in intensity observed at middle and low altitudes during this period. These intensity increases occurred almost in coincidence with the maximum depression of geomagnetic field intensity. Results of data analyses led to the conclusion that the intensity increases were caused by the decrease of cut-off rigidities due to these depressions of geomagnetic field intensity. (M.C.G.)

4574 TIME VARIATIONS OF COSMIC-RAY INTENSITY UNDERGROUND AT LOW LATITUDE. Victor H. Regener and James F. Kenney (Univ. of New Mexico, Albuquerque). p.216-18 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

A vertical, narrow-angle μ meson telescope was operated underground at a depth of 30m water equivalent at Chacaltaya Laboratory, Bolivia. The counting rate was 5000 threefold coincidences per hr. This high counting rate made it possible to carry out a harmonic analysis of the data obtained during each day. While analysis for a 12-hr period gave no significant results, 24-hr periods were found on 68 days between January 17 and May 30, 1959. This amplitude was as large as that found previously at surface stations at higher latitudes. This could be understood on the basis of the solar stream theory only if unusually large solar diurnal variations were found at lower energies at other laboratories during the same period. (M.C.G.)

4575 THE COSMIC RAYS "PREDECREASES" (PREBAISSE) IN THE MAXIMUM SOLAR ACTIVITY PERIOD (APRIL 1957–DECEMBER 1958). J. P. Legrand (Technical Services of the French Army). p.219-27 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

It was found that several days before big cosmic-ray storms, a small decrease (1 to 3%) in cosmic-ray intensity occurred. This small decrease, called a beginning of the "predecreases" generally coincides with the appearance of high-solar activity and sometimes with an increase of magnetic agitation. From April 12, 1957 to December 1958 four types of "predecreases" having different characteristics were found. It was found that the beginning of a "predecrease" could occur in two ways: at the same time as the appearance of a sunspot or cluster of very active sunspots on the east limb of the sun or 20 to 60 hr after a solar flare accompanied by radioelectric processes. It appears that the beginning of a "predecrease" is but a cosmic-ray storm of small amplitude. (M.C.G.)

4576 AN ISOTROPY AND THE ORIGIN OF THE SOLAR DAILY VARIATION OF COSMIC RAY INTENSITY. V. Sarabhai (Physical Research Lab., Ahmedabad, India), S. P. Duggal, U. R. Rao, H. Razdan, T. S. G. Sastry, and R. Palmeira. p.231-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

Experimental results concerning time variations of cosmic rays are presented. The time of maximum was found to shift by almost 10 hr in 19 years, reflecting the very significant change of form of the daily variations. The change was most rapid during increasing solar activity. The daily variation of meson intensity had on many days an amplitude large enough to allow the atmospheric temperature effect to be neglected. It was found that the diurnal amplitude for east intensity was larger than for west and the time of maximum for the west had much greater variability than for the east. It was concluded that on geomagnetically quiet days, there was an absence of a local source of daily variation, which permitted the observation of daily variations at greater distances in space. Features of the cosmic-ray storm of February 11, 1958, are discussed. (M.C.G.)

4577 SOLAR DIURNAL VARIATION OF COSMIC RAYS. K. Nagashima (Nagoya Univ., Japan). p.240-2 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The effects of magnetic fields uniformly frozen and randomly distributed in the solar stream on the anomalous diurnal variation of cosmic rays during cosmic-ray storms were investigated. It was found that a uniform magnetic field produced larger anomalous diurnal variations than the random field if the dimension of the cloud and magnetic field strength were the same. (M.C.G.)

4578 24-HOUR VARIATION OF THE HARD COMPONENT OF COSMIC RADIATION AT MINIMUM OF SOLAR ACTIVITY. E. S. Glokova. p.243-51 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The anomalous behavior of solar-diurnal variations during minimum solar activity is considered based on materials from 10 stations. The mean 24-hr variations were calculated for each month, with days having incomplete data excluded. A harmonic analysis was performed; the harmonic coefficients of the first harmonic were averaged for the seasons. In order to obtain the mean-year vectors, the seasonal vectors were averaged over the four seasons by the method of sliding means. Thus successive mean-year vectors were obtained one season apart from each other. (auth)

4579 INTENSITY VARIATIONS OF COSMIC RAYS UNDERGROUND. A. I. Kuzmin. p.252-7 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

Measurements of the intensity of the hard component of cosmic radiation were made by means of semi-cubic telescopes underground at depths of 7, 20, and 60 m water equivalent. It was found that the temperature effect did not mask the true 24-hr variation as much underground as at the surface. The amplitude of 24-hr variations of the neutron component did not exceed the amplitude of corresponding true variations of the μ meson component. The 24-hr variations did not experience perceptible alterations from 1957 to 1959. During magnetic storms there occurred characteristic intensity variations underground. The 27-day intensity variations of all components were evident both prior to and after corrections for temperature effect. (M.C.G.)

4580 ON THE DIURNAL VARIATION OF COSMIC-RAY INTENSITIES. Harald Trefall (Universitetet, Bergen, Norway). p.258-61 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

Recordings of the hard and soft secondary cosmic-ray components performed in Bergen, Norway, from August to November 1956 were analyzed for diurnal variations. The amplitude of the soft component was found to be about 50% greater than that of the hard component. The hard component was measured with several telescopes of different opening angles, but no significant differences were found between the corresponding amplitudes. However, the maximum of the diurnal variation observed with the most narrow-angle telescope (±6° in the East-West plane) occurred about 3 hr earlier than with the vertical telescopes of larger opening angles. The amplitude observed with an east-pointing telescope was approximately 3 times greater than for the vertical telescopes, but the phase was not significantly different. The amplitude observed with a west-pointing telescope was the same as for the vertical telescopes, but the diurnal maximum occurred about 7 hr later. (auth)

4581 A LUNAR COSMIC RAY INTENSITY VARIATION. E. Bagge and O. Binder (Institute für Reine und Angewandte Kernphysik, Kiel, Ger.). p.262-70 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

This paper was previously abstracted from the original language and appears in NSA, Vol. 13, abstract No. 19527.

4582 24-HOUR INTENSITY VARIATIONS OF COSMIC RAYS OF ENERGY 2×10^{14} AND 2×10^{15} EV. D. D. Krasilnikov. p.271-2 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The solar-diurnal and sidereal-diurnal variations in the frequency of air showers recorded with G-M counter separations of 3.8 and 57 m were found to have an amplitude of 0.2% or less. (M.C.G.)

4583 THE SOLAR VARIATION IN RATE OF EXTENSIVE AIR SHOWERS. C. B. A. McCusker, D. E. Page, and R. J. Reid (Dublin Inst. for Advanced Studies). p.281-4 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

Variations in the rate of extensive air showers were detected at several locations. There was almost no variation in rate with sidereal time; but, in all cases, both 12- and 24-hr waves were present. It is suggested that the variation is due to a change in the structure of the showers with time which in turn is due to a change in the height of the first interaction. This variation in the height of the first interaction appears to be due to oscillations of the atmosphere. (M.C.G.)

4584 CERTAIN EXPERIMENTAL RESULTS IN STUDIES OF COSMIC-RAY VARIATIONS AT HIGH AND MIDDLE LATITUDES. E. S. Glokova and O. I. Inozemtseva. p.293-300 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The peculiarities of cosmic-ray variations in high latitudes as compared with moderate latitudes were studied. Results of investigations of seasonal and 24-hr variations, the intensity day-to-day variations, 27-day variations, and the effects of magnetic storms are presented. All variations were found to have a slightly greater amplitude in Mirny than in Moscow. The seasonal effect at both stations was totally excluded. According to the data on the neutron component; the ratio between variability, the amplitude of 27-day variations, and the effect of magnetic storms at Arctic stations and middle latitude stations, situated above the "knee" of the latitude effect, differed only slightly from unity. (M.C.G.)

4585 RECURRENT VARIATIONS OF COSMIC RAYS DURING SOLAR MAXIMA AND THEIR RELATION WITH OPTICAL ACTIVITY: SUNSPOTS AND CORONA. A. Fréon. p.301-4 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

It was observed that intensity variation of cosmic radiation showed a maximum amplitude and stability in a period of solar maximum activity. All observed variations were fairly sinusoidal. The phase shift varied linearly vs. time in the two modes of analysis used. The recurrent variation period remained constant. A general mean value of 27.40 ± 0.06 days was obtained. The stability of the observed recurrence implied a certain constancy of the solar structure during the same period of time. (M.C.G.)

4586 INDEX OF COSMIC RAY ACTIVITY AND ITS CONNECTION WITH MAGNETIC, IONOSPHERIC AND SOLAR ACTIVITY. K. K. Fedchenko. p.305-7 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

An attempt was made to find some quantitative characteristics or an index characterizing the extent of cosmic-ray activity within some period of time. Results indicated the presence of essential and statistically important correlations between cosmic-ray activity and magnetic activity. It was found that in days with magnetic and ionospheric disturbances and increased solar activity, an essential increase in cosmic-ray activity took place in both high and middle latitudes. (M.C.G.)

4587 THE COSMIC RAY TIME VARIATIONS AND THE SOLAR MAGNETIC FIELD. H. Elliot, R. J. Hynds, J. J. Quenby, and G. J. Wenk (Imperial Coll. of Science and Tech., London). p.311-19 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

A brief survey is presented of recent work on the interpretation of cosmic-ray intensity variations. An attempt is made to relate these variations to changes in the primary energy spectrum. Primary momentum spectra were constructed for the period of a sunspot maximum and for the first two days of a large Forbush decrease. The daily variation of intensity provided no direct evidence for the presence near the earth of systematically orientated magnetic fields carried out from sunspot regions. Graphs show the changes in form of the primary spectrum from sunspot minimum to sunspot maximum. (M.C.G.)

4588 ON THE THEORY OF THE MODULATION OF COSMIC RAYS BY THE SOLAR WIND. L. I. Dorman. p.320-9 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of the Cosmic-Ray Intensity."

The hypothesis of Parker that the 11 yr variation of cosmic radiation associated with variations in solar activity can be explained by diffusion due to a drift of magnetic field inhomogeneities from the sun (solar wind) is discussed. Certain alterations were made having to do with selecting the particle range for scattering on inhomogeneities, the convection rate, the picture of distribution of solar wind, and the necessity of taking into account deceleration of particles by an anti-Fermi mechanism in the expanding solar wind. Singer's alternative mechanism for explaining the variations in cosmic radiation is also discussed. Evaluations showed that both are sufficiently and almost equally effective in explaining the variations. (M.C.G.)

4589 THE SECULAR VARIATION OF COSMIC-RAY LATITUDE EFFECT. S. Fukushima and M. Kodama (Inst. of Physical and Chemical Research, Tokyo). p.330-3 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The latitude survey of the cosmic-ray nucleonic component at sea level was carried out during November 1958 to April 1959. The results indicated that the spectrum of cosmic rays changes in spite of solar activity. It was found that the effects of solar activity on cosmic rays does not become apparent until some substances emitted from solar-active regions (e.g., magnetic clouds) accumulate to a certain extent in space. (M.C.G.)

4590 [SOLAR DISTURBANCES AND THE COSMIC-RAY EQUATOR.] M. A. Pomerants (Bartol Research Foundation, Swarthmore, Penna), A. E. Sandström, V. R. Potnis, and D. C. Rose. p.337-43 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The location of the cosmic-ray equator off the west coast of Africa was established from measurements obtained with a shipboard neutron monitor that made ten crossings between November 1956 and October 1958. From the individual determinations of the point of minimum cosmic-ray intensity, the mean geographical position was 6.7 ± 8°N at 14°W. Direct measurements of zero magnetic inclination were made at the same time in the immediate vicinity of this point. Although solar and geophysical activity varied considerably during this period, the location of the cosmic-ray equator appears to have remained fixed within approximately 1°. However, the possibility of a small progressive change of about the magnitude of the uncertainty cannot be precluded. Comparison of the results with plots of measurements of the magnetic elements along the ship's route reveals a significant difference between the location of the points of maximum horizontal intensity and minimum cosmic-ray intensity. (auth)

4591 THE WORLD-WIDE DISTRIBUTION OF COSMIC-RAY NEUTRON INTENSITY AT SEA LEVEL. Masahiro Kodama (Inst. of Physical and Chemical Research, Tokyo). p.349-61 of "Proceedings of the Moscow Cosmic Ray Conference, July 6-11, 1959. Volume IV. Variations of Cosmic-Ray Intensity."

The world-wide distribution of cosmic neutron intensity at sea level was decided from the several latitude curves that have been measured by many researchers. The contour map thus obtained was compared with the various models for the earth's geomagnetic field. (auth)

Criticality Studies

4592 (GAT-T-692) PRACTICAL METHODS FOR CALCULATING REACTIVITY OF HOMOGENEOUS URANIUM COMPOUNDS. J. L. Feuerbacher. Goodyear Atomic Corp., Portsmouth, Ohio. Oct. 15, 1959. 22p. Contract AT(33-2)-1. OTS.

Methods used in reactivity calculations for hydrogen-moderated homogeneous systems of uranium compounds are outlined. The assay and moderation were assumed to vary over the ranges 0.72 to 100% U^{235} and H/U = 0.33 to ∞. Uranium densities were varied from 0 to 3.2 g/cc. (W.D.M.)

4593 (LA-2468) DOSIMETRY FOR THE LITTLE EVA CRITICAL ASSEMBLY; NEUTRON FLUX, SPECTRUM, AND TISSUE DOSE EVALUATIONS. J. A. Sayeg, D. G. Ott, and P. S. Harris. Los Alamos Scientific Lab., N. Mex. May 1960. 25p. Contract W-7405-eng-36. OTS.

The leakage neutron flux and spectrum and the neutron and γ dose vs. distance relations were determined for the Little Eva critical assembly. These measurements were accomplished with the threshold detectors Pu^{239}, Np^{237}, U^{238}, and S^{32} for the evaluation of fast-neutron flux, spectrum, and neutron tissue dose; and bare and cadmium-covered gold foils were used for the evaluation of the thermal flux. The γ dose was determined with tetrachloroethylene chemical dosimeters. The measurements show this assembly to have the lowest γ-to-neutron dose ratio of any assembly tested to date. (auth)

4594 (WAPD-TM-244) NUCLEAR ANALYSIS OF THERMAL REFLECTED CYLINDRICAL HOMOGENEOUS CRITICAL ASSEMBLIES. G. P. Rutledge and P. A. Kantorczyk. Nov. 1960. 21p. Contract AT-11-1-GEN-14. OTS.

Twenty-three small, cylindrical, UO_2F_2 aqueous solution, water-reflected, critical assemblies were analyzed utilizing few-group diffusion theory with the one-dimensional code WANDA. The fast-group constants were obtained using the MUFT code which computes the flux spectrum in a material of prescribed composition and buckling. The cross sections are then averaged over this spectrum to obtain the MUFT constants. Maxwellian thermal spectrum constants for the slow group were obtained with the SOFOCATE code. Also, three large, $UO_2(NO_3)_2$ aqueous

solution, cylindrical critical assemblies were analyzed for comparison. The purpose of the analysis was to make several direct comparisons of critical experiments with analytical models in order to determine whether these models can be utilized to calculate criticality for assemblies that are not complicated with heterogeneous structural materials. The general use of these analytical models for fuel handling criticality calculations was evaluated. (auth)

Elementary Particles and Radiations

4595 (ARL-TN-60-117) THE EFFECT OF AN EXTENDED PARTICLE MODEL ON THE RUNAWAY SOLUTIONS OF CLASSICAL ELECTRON THEORY. S. I. Fickler and R. Arnowitt. Syracuse Univ., N. Y. 1959. 32p. Contract AF33(616)-5598. (AD-236846).

The Lorentz self-force for an extended classical particle is examined. The analysis is done in the nonrelativistic limit. A general form for the self-force is obtained in quadrature. This can be expanded in a series increasing nonlinearly in the position vector of the particle. The first term of this series reduces correctly in the limit of a point particle to the standard Lorentz result. For a simple model of an extended electron, however, it is shown that this term yields no unphysical runaway solutions of the equations of motion. A technique for expressing the higher terms of the series in closed form is described. No procedure for summing all these higher terms seems available. (auth)

4596 (NAA-SR-Memo-5327) EXPERIMENTAL PROBLEMS ASSOCIATED WITH THE MEASUREMENTS OF THE DIFFUSE SCATTERING OF X-RAYS. David J. Klein (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). May 26, 1960. 18p. Program and Project: 7513-4257. OTS.

The x-ray geometries employed in the various common x-ray techniques are compared, with the aid of the Ewald diagram in reciprocal space. The geometrical requirements of the measurement of diffuse scattering are discussed, using the same techniques, relating the simpler modes of scan to the common Laue-Bragg techniques in x-ray diffraction. Other intensity and background problems are listed, and the corrections necessary to reduce the data to absolute units of diffuse scattering intensity are noted. (auth)

4597 (NARF-60-8T(Vol. II)) MONTE CARLO CALCULATIONS OF FAST-NEUTRON SCATTERING IN AIR. VOLUME II. M. B. Wells. Convair, Fort Worth, Tex. Aug. 19, 1960. 276p. Contract AF33(600)-38946. (FZK-9-147(Vol. II)).

The results of a Monte Carlo calculation of the scattering of fast neutrons in an infinite medium of air, which include the effect of inelastic scattering, are presented in terms of angular distributions, energy spectra, and tissue dose rates at source–detector separation distances of 10, 35, 64, and 100 ft. The results were obtained for neutron-source energies of 0.33, 1.1, 2.7, 4, 6, 8, 10.9, and 14 Mev and source angles, with respect to the source-detector axis, of 5, 15, 30, 60, 90, 120, 150, and 180°. Tables give the angular distributions of the air-scattered neutron energy spectra for all the source energies, source angles, and source–detector separation distances included in the parameter study. (auth)

4598 (NYO-9264) MEASUREMENT OF THE WOLFENSTEIN PARAMETER R AT 210 MEV. W. A. Gibson, A. C. England, E. Heer, and J. H. Tinlot. Rochester, N. Y. Univ. Aug. 1, 1960. 128p. OTS.

The incident 210 ± 2 Mev, 89% polarized, proton beam was scattered from liquid hydrogen; and $R(\theta)$ was measured for the center of mass angles at 30 to 90° in 10° steps. The results of the experiment are compared with predictions based on phenomenological potential models. (auth)

4599 (ORNL-3010) GROUP-THEORETICAL TREATMENT OF TIME- AND ENERGY-DEPENDENT MULTIPLE SCATTERING, WITH APPLICATION TO THE SLOWING-DOWN OF NEUTRONS. E. Guth and E. Inönü (Oak Ridge National Lab., Tenn.). Nov. 2, 1960. 19p. Contract W-7405-eng-26. OTS.

Wigner's work on multiple scattering in which the elementary scattering law is invariant under a group of transformations is extended to include the time-dependent slowing-down of neutrons. A group of linear transformations was found which does not yield orthogonality. Nevertheless, it is shown possible to determine all positive time moments of the distribution function, and from them, the distribution function itself. The conditions for the existence of the group are that the total scattering cross section is proportional to v^γ (γ is any real number) and that either the ratio of absorption to scattering cross section is constant (including zero) or the absorption cross section varies as 1/v. Moreover, it is assumed that the angular dependence can be anisotropic but does not depend on energy in the center-of-mass system. For the special case of no absorption and spherically symmetric elastic scattering in the center-of-mass system, the solution reduced to Waller's recent exact expression. As a further generalization, discussions are presented on the group which, with the same assumptions about the cross sections, exists for the case of time-energy-space-direction dependence. The group-theoretical method yielded all positive moments of the distribution functions for this case. (auth)

4600 (UCRL-9191) SCATTERING OF POSITIVE PIONS ON PROTONS AT 310 Mev: RECOIL-NUCLEON POLARIZATION AND PHASE-SHIFT ANALYSIS (thesis). James Herbert Foote (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 16, 1960. 131p. Contract W-7405-eng-48. OTS.

The recoil-proton polarization in π^+-p elastic scattering at 310-Mev incident-pion laboratory kinetic energy was measured at four scattering angles with plastic scintillation counters. These polarization results were combined with accurate differential- and total-cross-section data at 310 Mev, and a comprehensive phase-shift analysis was performed. The D-wave phase shifts were definitely needed to attain an adequate fit to the data. A general search for phase-shift solutions was carried out by using S-, P-, and D-wave phase shifts. The solution that best fits the data is of the Fermi type. The calculated errors in the phase shifts varied from 0.4 to 0.6°. Because it was felt that these errors might be deceivingly restrictive, the effects of small nuclear F-wave phase shifts on the results of the analysis were investigated and were found to be large; not only are the uncertainties in the original Fermi type solution increased but also additional sets of phase shifts that fit the data well arise. One of the solutions is similar to the original Fermi set except that the magnitudes of the phase shifts in this new fit are, in general, larger than those in the initial solution, and the signs of the D-wave phase shifts are reversed. Inelastic-scattering processes

were neglected during the phase-shift analysis. Extension of the phase-shift inquiries to include G waves was attempted, but it was observed that the available data and theory do not allow the G-wave interaction to be significantly incorporated into the analysis. The sign of the recoil-proton polarization is defined to be positive when a preponderance of the protons recoiling to the right side of the incident π-meson beam had their spin vectors pointing up. A beam of 1×10^6 pions/sec incident upon a 1.0 g/cm^2 thick liquid-hydrogen target produced the recoil protons, which were then scattered by a carbon target at a mean energy varying with recoil angle from 113 to 141 Mev. The polarization of the recoil protons was analyzed by measuring the asymmetry produced in the carbon scattering. (auth)

4601 (UCRL-9278) TOTAL CROSS SECTIONS FOR NEGATIVE PIONS ON PROTONS AT 230, 290, 370, 427, AND 460 MEV. John C. Caris, Lester K. Goodwin, Robert W. Kenney, Victor Perez-Mendez, and Walton A. Perkins, III (California. Univ., Berkeley. Lawrence Radiation Lab.). June 15, 1960. 19p. Contract W-7405-eng-48. OTS.

Total cross sections for negative pion interactions with protons were measured at laboratory-system energies of 230, 290, 370, 427, and 460 Mev. The total cross sections agree within statistical error with other measured values, and with values calculated from sums of elastic, inelastic, and charge-exchange measurements. (auth)

4602 (UCRL-9455) AN EXPERIMENTAL CHECK ON THE RANGE-ENERGY CURVE OF PIONS IN PROPANE. Jack W. Patrick (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 24, 1960. 8p. Contract W-7405-eng-48. OTS.

The kinetic energies of pions from τ^+ decays in propane were determined using secondary particle angles. A comparison of the results with energies using a theoretical range-energy curve gave a ratio of 1.06 ± 0.03. The range interval of 4 mm to 14 cm was investigated. (C.J.G.)

4603 (AEC-tr-3592) RESEARCH IN PHYSICS OF HIGH ENERGY PARTICLES AT THE SYNCHROCYCLOTRON OF THE LABORATORY OF NUCLEAR PROBLEMS OF THE JOINT INSTITUTE FOR NUCLEAR RESEARCH. Translation of (Issledovaniya po Fizike Chastits Vysokikh Energii na Sinkhrotsiklotrone Laboratorii Yadernykh Problem Ob'edinennogo Instituta Yadernykh Issledovanii). V. P. Dzhelepov and B. M. Pontekorvo (Pontecorvo). Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems. 1957. 29p. JCL or LC.

Also published in Atomnaya Energ. 3, 413-43(1957).

The fundamental research that is being conducted by Soviet physicists with high-energy particles, using the synchrocyclotron of the Laboratory of Nuclear Problems of the Joint Institute for Nuclear Research, is reported. (W.L.H.)

4604 EXPERIMENTAL INVESTIGATION OF THICK TARGET BREMSSTRAHLUNG RADIATION PRODUCED BY ELECTRONS OF 1.00, 1.50 AND 2.00 MeV. E. A. Edelsack, W. E. Kreger, W. Mallet, and N. E. Scofield (U. S. Naval Radiological Defense Lab., San Francisco). Health Phys. 4, 1-15(1960) Oct.

Measurements were made of the 0° bremsstrahlung spectrum emerging from thick targets of polystyrene, aluminum, copper, silver, and gold bombarded by monoenergetic electrons of 1.0 Mev, 1.5 Mev, and 2.0 Mev. The measurements were made using a 4-in.-diameter by 4-in.-long NaI(Tl) scintillation detector unit with a lead shield and collimator. The pulse-height spectra were recorded in a twenty-channel, pulse-height analyzer and converted to photon spectra using an experimentally determined response matrix for the scintillation detector. Corrections and errors are discussed, and the results are plotted as families of curves of number of photons per mega-electron volt per microampere per steradian at zero degrees vs. photon energy. Comparisons are made with some elementary semi-empirical predictions of thick-target bremsstrahlung spectrum shapes. (auth)

4605 I–Xe DATING OF METEORITES. J. H. Reynolds (Miller Inst. for Basic Research in Science, Berkeley, Calif. and Univ. of California, Berkeley). J. Geophys. Research 65, 3843-6(1960) Nov.

The method of dating meteorites by irradiating with thermal neutrons and analyzing the xenon by mass spectrometry is applied to two 1-g fragments of the Richardton stone. The results differ for the two samples, and some of the possible causes of this difference are discussed. The substitution of Xe^{130} for Xe^{136} in the subtraction of terrestrial xenon does not resolve the difference. (D.L.C.)

4606 ENERGY SELECTION OF FAST NEUTRONS BY TIME-OF-FLIGHT. R. Ballini and L. G. Kuo (Centre d'Etudes Nucléaires, Saclay, France). J. phys. radium 20, Suppl. to No. 4, 47A-8A(1959) Apr. (In French) (CEA-1278)

The beam of the Saclay 5-Mev Van de Graaff is pulsed at a few megacycles frequency. The fast neutron time-of-flight spectrum is registered in a 99-channel pulse-height analyzer, through a time-to-pulse height converter. (auth)

4607 INTERACTION TYPES AND SELECTION RULES IN BARYON PROCESSES. Seitaro Nakamura (Tokyo Univ.). J. Phys. Soc. Japan 15, 2108-9(1960) Nov. (In English)

An interaction Hamiltonian of the strong interaction for baryons was found by assuming new symmetry, κ-charge independence, which is an extension of the symmetrical meson theory. The existence of 16 kinds of mesons that mediate the strong interactions among baryons was also assumed. From the final expressions for the interaction Hamiltonians, the selection rules to determine baryon processes were inferred. The conservation of baryon number, conservation of κ-charge, and conservation of strangeness are implied in the rules. (M.C.G.)

4608 STRONG INTERACTION OF BARYONS. Seitaro Nakamura (Tokyo Univ.). J. Phys. Soc. Japan 15, 2122-3 (1960) Nov. (In English)

For strong interactions of baryons, the three-dimensional representation led to violation of strangeness. An attempt was made to find a new quantum number that would take the place of strangeness. A two component spinor and a new charge $Q_\kappa = (1 + \kappa_3)/2$, which is 1 for p and 0 for q, are introduced. A strong interaction between p and q through four groups of mesons is assumed. It was found that charge independence in the ordinary isospin representation is valid in strong interactions, except in processes involving D^0 mesons. (M.C.G.)

4609 NUCLEAR CAPTURE OF MU MESONS. Włodzimierz Kusch (Inst. for Nuclear Research, Warsaw). Postepy Fiz. 11, 69-82(1960). (In Polish)

After a brief history of early discoveries and difficulties relating to π and μ mesons, this review article follows the theoretical and experimental developments of the interaction of negative μ mesons with nuclei. Twenty-six references to μ meson capture are listed. First, the basic inter-

action with a proton, the mechanism of the interaction, and the probability of capture of a negative μ meson as a function of Z are treated. Next, the side products (emission of nucleons) resulting from the capture of a μ meson by a proton in a nucleus and from the subsequent excitation of this nucleus are discussed. Measurements of emission probability of N neutrons (N = 0, 1, 2...) are compared with the predictions of 3 nuclear models. The last section deals with observations that have the capability of demonstrating nonconservation of parity, in particular, the measurements of angular distributions of neutrons emitted after the capture of polarized μ mesons by nuclei. (TTT)

4610 ON THE TEST OF GLOBAL SYMMETRY. Shin-ya Furui and Tetsuro Sakuma (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto) 24, 18-26(1960) July. (In English)

An attempt to investigate the concept of global symmetry on the strong interactions in the pion-baryon system is presented. To this end, the absorption processes of K^--meson by protons are investigated at low energies. The general relations of complex phases in K^--P absorption are also presented. Rather conclusive evidence is obtained for inconsistency of global symmetry with the present experiments. The effects of the intermediate $\bar{K}$-N states and Λ states are also discussed. It should be noted that this conclusion is derived only by kinematical considerations and not by details of dynamics in the model. (auth)

4611 ON RATIOS OF THE RENORMALIZED AND THE BARE COUPLING CONSTANTS IN THE BETA DECAY INTERACTION. Ichiro Kawakami (Rikkyo Univ., Tokyo). Progr. Theoret. Phys. (Kyoto) 24, 27-34(1960) July. (In English)

The ratio of the renormalized and the bare coupling constants in the β-decay interaction is calculated in two ways. The first is evaluation of the contribution from the process in which a neutron and an antiproton, which virtually exchange an infinite number of pions, are annihilated into an electron-neutrino (or antineutrino) pair. For this purpose a dispersion relation for the vertex function of the β-decay is assumed. Using this relation the ratio is calculated in the "ladder" approximation of Federbush, Goldberger, and Treiman. The result is that the ratio is smaller than unity. The second way is calculating the ratio so as to include the main contribution from virtual nucleon pairs. For this purpose an equation is derived for the vertex operator of the β-decay. The vertex operator is calculated using Goto and Machida's approximation. The result is that the ratio for the axial vector coupling constants is larger than unity, while that for the vector coupling constants is smaller than unity. The experimental value for the ratio (~1.2) is reproduced at a rather small cutoff energy (~ one-pion rest mass). (auth)

4612 ELECTROMAGNETIC MASS DIFFERENCE OF ELEMENTARY PARTICLES. Hiroshi Katsumori (Osaka Gakugei Univ.). Progr. Theoret. Phys. (Kyoto) 24, 35-58 (1960) July. (In English)

The question whether the observed mass difference between the members of each charge multiplet, for both baryons and mesons, can be explained in terms of an electromagnetic self-energy is examined. The electromagnetic form factor is introduced to play the role of cutoff factor, and the isospace transformation property of each individual elementary particle is taken into account for the phenomenologically assumed form factor. The following results are obtained from the e^2-order self-energy calculation: (1) The observed neutron-proton mass difference ($2.5m_e$) may be explained using the suitable form factor which is assumed to agree with the empirical one for the momentum transfer below 1 bev/c. The desirable behavior of the form factor for the higher momentum transfer is shown with a few examples, which may suggest some information about the inner structure of the nucleon. The calculated mass difference has no direct close connection with the root-mean-square radius of the charge or magnetic moment distribution but strongly depends upon the higher momentum behavior of the form factor. (2) The similar argument seems favorable for understanding that the observed $\Sigma^- - \Sigma^+$ mass difference is considerably larger ($13m_e$), while $(M_{\Sigma^+} + M_{\Sigma^-})/2 - M_{\Sigma^0}$ is comparatively small ($\sim 1.5m_e$). (3) Both the observed $\pi^\pm - \pi^0$ mass difference ($9m_e$) and the observed $K^0(\bar{K}^0) - K^\pm$ mass difference ($8m_e$) may also be understood if the suitable form factors are assumed according to the isospace transformation property of each meson. (4) Although no experimental data have been made available about the $\Xi^0 - \Xi^-$ mass difference with sufficient accuracy, the argument similar to that for the nucleon leads to some conjectures. Finally, the strong interaction corrections to the mass shift are estimated for the baryons and mesons in the lowest approximation of g^2. This effect cannot be thoroughly neglected, but in most cases it seems to be regarded as a small correction to the main electromagnetic effect. (auth)

4613 A POSSIBLE INTERPRETATION OF HIGH ENERGY NUCLEAR EVENTS. Nobuo Yajima (Osaka Univ.), Shuji Takagi, and Keizo Kobayakawa. Progr. Theoret. Phys. (Kyoto) 24, 59-80(1960) July. (In English)

A method of analyzing the data of high-energy jet showers in nuclear emulsions is proposed. The possibilities of reducing the nucleon-nucleon collisions to pion-nucleon interactions are discussed. The experimental data on π^--p collision at 5 bev as the pion-nucleon interaction are used to estimate the energy and angular distribution of emitted pions in rather low energy jet showers ($\lesssim$100 bev), and the obtained results fairly agree with the experiments. As to the high-energy jet showers ($\lesssim$100 bev), almost all the collisions are regarded as peripheral ones and the properties of the pion-nucleon interaction obtained from the nucleon-nucleon collision are similar to those of the pion-nucleon interaction actually observed. It is also suggested that the nucleon has a core whose radius is about a nucleon Compton wavelength. (auth)

4614 COMPOSITE MODEL AND THE NATURE OF VECTOR INTERACTIONS IN STRANGENESS-VIOLATING DECAYS. Chikashi Iso, Masaaki Kawaguchi, and Yoneji Miyamoto (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto) 24, 97-110(1960) July. (In English)

Decay interactions based on Sakata's composite model in which neutron, n, proton, p, and Λ-particle are supposed to be elementary are discussed. Symmetry with respect to n, p, and Λ is also assumed. Then it is shown that (πK) currents are necessarily added to the usual strangeness-violating ($|\Delta S| = 1$) baryon vector currents in the conventional Yukawa type interaction. This is analogous to the situation that ($\pi\pi$) and (KK) currents necessarily appear in the $|\Delta S| = 0$ leptonic decay interaction in the Sakata model. By taking the (πK) currents into account, the transition probabilities for K_{e3}, $K_{\mu 3}$, and β- and μ-decays of Λ are shown to be consistently described with the same coupling constant as that obtained from $K^+_{\mu 2}$ decay. Thus the coupling constant for strangeness-violating leptonic decays seems to be smaller than that for strangeness-conserving

ones. For nonleptonic decays the hamiltonian, which guarantees the $|\Delta I| = \frac{1}{2}$ selection rule, is easily found by virtue of the additional neutral terms with the universal coupling constant. The lifetimes and branching ratios for nonleptonic decays of Λ and K are in good agreement with experiment in terms of the normal β-decay coupling constant. The situation is a little complicated for $K_{\pi 3}$. Admixture of $|\Delta I| = \frac{3}{2}$ transitions are also briefly discussed. Some comments are made on the observability of π^0, a neutral meson having an isotopic spin 0. (auth)

4615 A STUDY ON THE LOW ENERGY n–p SYSTEM. Tetsuo Hamada (Univ. of Sydney). Progr. Theoret. Phys. (Kyoto) 24, 126-34(1960) July. (In English)

The deuteron properties and the zero energy n-p scattering parameters are computed for a number of potentials. These potentials are characterized by the one-pion-exchange tail and the semiphenomenological inner interaction. The numerical results reported provide a basis on which one can estimate the consequence of any reasonable potential consistent with the pion theory as far as the low-energy n-p system is concerned. (auth)

4616 THE PROTON–NEUTRON MASS DIFFERENCE AND THE INNER STRUCTURE OF THE NUCLEON. Takeshi Kanki and Kunio Yamamoto (Osaka Univ.). Progr. Theoret. Phys. (Kyoto) 24, 135-48(1960) July. (In English)

A method is proposed which makes it possible to take into account the contribution from the pair state in the calculation of the proton-neutron mass difference without regard to the form of the matrix elements related to the pair state. It is shown that there exists a considerable difference between the result of our method and that of the Feynman-Speisman method in the internal region of the nucleon cloud. The model of form factors is considered in which the core exists only in the charge isoscalar part. The result derived from this model is not satisfactory owing to the wrong sign of the mass difference. In order to get a good agreement with the empirical data it would be necessary to introduce a core at least into one of the form factors of the charge isovector type and of any kind of the magnetic moment type. The magnitude and the sign of the core is briefly estimated for each type of form factors. (auth)

4617 NEUTRINO AND COSMOLOGY. Asher Peres (Israel Inst. of Tech., Haifa). Progr. Theoret. Phys. (Kyoto) 24, 149-54(1960) July. (In English)

The elementary relativistic cosmological model is refined by taking into account the proper motions of particles. It is found that the latter were in the past much faster than now, and it is thereby inferred that there must actually exist, in the universe, a large population of low-energy neutrinos, due to previous high-energy nuclear reactions. It is shown how these neutrinos can be detected through their gravitational influence. In case they fail to be detected, it is concluded that there exists a possibility of annihilation of neutrino-antineutrino pairs. (auth)

4618 ON THE INTERACTION IN NUCLEON CORE. Shigeo Minami (Osaka City Univ.). Progr. Theoret. Phys. (Kyoto) 24, 216-18(1960) July. (In English)

The value of the coupling constant in the nucleon core is treated from the viewpoint of field theory taking into account the spread of the core. The core is treated as a point, and equations are derived for the pion-nucleon interaction. The coupling constant is $gF(Mx)$ with $F = \mu/2M$ in terms of nonlocal field theory. The interaction strength in the core may become much weaker than that in the outer region, leading to a very small contribution from the nucleon current to the anomalous nucleon magnetic moment, which would explain the experimental moment. (D.L.C.)

4619 SOME REMARKS ON FERMI-YANG MODEL. Yasusi Ataka (Kinki Univ., Osaka). Progr. Theoret. Phys. (Kyoto) 24, 218-20(1960) July. (In English)

The π-π and K-particle-nucleon potentials are derived using the Fermi-Yang model in which the many-body correlations between fundamental particles are neglected and the π-nucleon interactions are reduced to two-body interactions between fundamental particles. It is concluded that the π-π potentials are strongly attractive for T = 0, attractive for T = 1, and repulsive for T = 2, and that the K-particle-nucleon state is repulsive for T = 1 and the $\bar{K}$-particle-nucleon state is attractive for T = 1. (D.L.C.)

4620 A PROTON–PROTON POTENTIAL. Tetsuo Hamada (Univ. of Sydney). Progr. Theoret. Phys. (Kyoto) 24, 220-2(1960) July. (In English)

An energy-independent p-p potential partially consistent with available p-p scattering data was developed on the basis of a one-pion-exchange tail and a weak quadratic spin-orbit (Q) potential. The equation parameters giving the best over-all fit to the experimental data are presented, and the calculated results for 95 and 145 Mev are plotted as a function of angle for comparison with experimental points; the fit at lower energies is satisfactory, although the calculated phase shifts at 310 Mev are close to those of MacGregor et al., for 310 Mev. (D.L.C.)

4621 NON-STATIC EFFECT IN THE T = 0 TWO-NUCLEON INTERACTION. Tetsuo Hamada (Univ. of Sydney). Progr. Theoret. Phys. (Kyoto) 24, 222-3(1960) July. (In English)

The nonstatic effects are shown from the experimental n-p total cross section at 300 Mev (σ_{np} = 35 mb) to be probably important in nucleon-nucleon interactions at 300 Mev for T = 0 states as well as for T = 1 states. The contribution to σ_{np} from T = 1 is estimated to be 11.7 or 10.4 mb from the phase shifts of MacGregor et al., and the contribution from triplet even phase shifts is calculated to be at least 20.7 mb, leaving only 3 to 4 mb for all other T = 0 states to contribute, which indicates that nonstatic effects must be significant. (D.L.C.)

4622 NOTE ON THE RADIATIVE CORRECTIONS FOR THE ELECTRON–ELECTRON SCATTERING. Kichiro Hiida (Kyoto Univ.), Toshiyuki Murota, Masako Goto, and Michio Sasanuma. Progr. Theoret. Phys. (Kyoto) 24, 223-5(1960) July. (In English)

The α^3 radiative corrections for electron-electron scattering cross sections at high energies are examined, and an equation for σ is obtained similar to that of Redhead and with a $(\log(E/m))^2$ term. It is pointed out, however, that if σ is expressed in the center-of-mass system and not the laboratory system, an equation is obtained with no $(\log(E/m))^2$ term. The radiative corrections are very large, even for $E \simeq 1$ Bev, the main contribution coming from real and virtual soft photon processes. Therefore it will be difficult to calculate the theoretical cross section at $E \simeq 1$ bev with sufficient accuracy. (D.L.C.)

4623 NOTE ON THE RADIATIVE CORRECTION TO ELECTRON–ELECTRON COLLISION. Hiroshi Suura (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto) 24, 225-7(1960) July. (In English)

The problem of the occurrence of a $(\ln(Ec/m))^2$ term in Redhead's calculation of the radiative correction for electron-electron collisions is discussed at length, and it is suspected that the term comes from contributions from soft quanta. The correct total cross section in the center-of-mass system is obtained from that in the laboratory frame (Redhead's frame of reference) by modifying the inelastic part of Redhead's cross section. (D.L.C.)

4624 PROPERTIES OF HEAVY PARTICLES. Gerhard Breitling (Universität, Tübingen, Ger.). Röntgen Bl. 13, 49-55(1960) Feb. (In German)

The properties, as well as the interaction between heavy particles and matter, are discussed, whereby conclusions are drawn for the therapeutic application of radiation. The characteristic deep doses of different particles are shown. (auth)

4625 CROSS SECTIONS FOR THE INTERACTIONS OF PARTICLES AT HIGH ENERGIES. V. S. Barashenkov (Joint Inst. for Nuclear Research, Dubna, USSR). Uspekhi Fiz. Nauk 72, 53-74(1960) Sept. (In Russian)

A comprehensive review is given of the interaction cross sections of various sorts of particles with energies above 0.8 Bev. The experimental data were tabulated and plotted for elastic, inelastic, and total cross sections for the bombardment of nucleons by nucleons, π mesons, anti-nucleons, and K mesons. π-π and K-π cross sections were inferred from other data. Nucleon-nucleon cross sections were found to be constant above 6 Bev, with protons indistinguishable from neutrons. The values are 22 mb inelastic, 8 mb elastic, and 30 mb total. Cosmic-ray data indicated that the total cross section is roughly constant up to 10^9 Bev. The total cross sections for negative π mesons on protons and neutrons are constant above 2 or 3 Bev and both equal to 30 mb. The inferred π-π cross section is also equal to this figure. Qualitative arguments are given for understanding the above results. The disappearance at high energies of a dependence on isotopic spin is explained by the availability of successively more inelastic reaction channels; the disappearance of ordinary channel spin dependence by the growing importance of higher orbital angular momenta. The dispersion relation for forward scattering is used to predict the equality at high energies of nucleon-nucleon and nucleon-antinucleon total cross sections. The lack of energy dependence suggests a hard-sphere "black" particle model; the effective meson radius is equal to that of a nucleon. An appendix discusses the evaluation of the mean free path of fast particles in nuclear emulsions. (TTT)

Nuclear Properties and Reactions

4626 (AHSB-Report-44) COMPREHENSIVE LIST OF NUCLIDES WITH A STATEMENT OF ATOMIC MASS, HALF-LIFE AND SPECIFIC ACTIVITY. N. J. Dunning (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England). Mar. 1960. 26p. BIS.

Terms used in the physics of radioactivity are defined, and a nuclear decay scheme is explained. Decay chains are discussed, and the equation for secular equilibrium is derived. The possible ambiguity in the use of the unit of specific activity (curie per gram) is pointed out, together with the definition of the "natural" curie. The formula from which the specific activity of pure nuclide in curies per gram of nuclide can be calculated is derived. Note is made of the fact that the value given by this formula differs from that obtained from the equation for specific activity of nuclides produced by neutron irradiation. Examples are given of how the values of specific activity quoted in this list can be used to obtain the specific activity of chemical compounds. (auth)

4627 (HaR-761) THE DISINTEGRATION OF 27-DAY Pa^{233}. L. G. Elliott and A. B. Underhill. [United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England]. [nd.]. 7p.

The β spectrum of 27-day Pa^{233} was studied in a magnetic lens spectrometer. A decay scheme is proposed. (C.J.G.)

4628 (UCRL-6094-T) THE NUCLIDE Hf^{182}. W. Hutchin and H. Lindner (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 28, 1960. 5p. Contract W-7405-eng-48. OTS.

The nuclide Hf^{182}, produced by thermal neutron irradiation of HfO_2, was found to have a half life of 8.5×10^6 years. Possible radiations associated with the nuclide are examined. (C.J.G.)

4629 (CEA-tr-R-385) INTERACTION DES NOYAUX D'AZOTE AVEC DES NOYAUX D'OR. (Interaction of Nitrogen Nuclei with Gold Nuclei). S. A. Baraboshkin (Barabochkine), A. S. Karamyan (Karamiane), and G. N. Flerov. Translated into French from Zhur. Eksptl'. i Teoret. Fiz. 32, 1294-7(1957). 11p.

Variations were obtained in the cross sections of the reactions Au(N,4n), (N,5n), and (N,6n) as a function of the nitrogen-ion energy. The irradiation was done in the "proof-plane" interior of a cyclotron by monoenergetic ions accelerated to 115 Mev. In agreement with the theory of concurrent processes, curves with strongly marked maxima were obtained. (tr-auth)

4630 SEARCH FOR INDEPENDENT FORMATION OF Cs^{134m} IN FISSION. A. P. Baerg, R. M. Bartholomew, and R. H. Betts (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem. 38, 2147-51(1960) Nov. (AECL-1099)

The independent yield of Cs^{134m} in thermal neutron fission of U^{235} is less than 1.7×10^{-4} of the mass 134 chain yield and that of Cs^{136} was found to be $(0.94 \pm 0.04) \times 10^{-3}$ of the mass 136 chain yield. The half-life for Cs^{134m} was measured as 2.91 ± 0.01 hr. (auth)

4631 DETERMINATION OF THE SPIN OF EXCITED LEVELS DURING NEUTRON CAPTURE BY TUNGSTEN-183. Vinh-Dinh Huynh, Jean Julien, Charles Corge, Francis Netter, and Jovan Simic. Compt. rend. 248, 2330-2(1959) Apr. 20. (In French) (CEA-1236)

By simultaneous analysis of the distribution in energy and in time of the γ rays produced by capture, in a tungsten target of neutrons selected by the time-of-flight method, the following values were found for the spin of the states of the compound nucleus W^{184} corresponding to the various capture resonances: J = 1 = (7.62, 27.1, 40.8, 46.6, and 65.7 ev); and J = 0 (48.1 ev). (auth)

4632 DECAY OF POTASSIUM 44. Kazusuke Sugiyama (Tohoku Univ., Sendai), Tsutomu Tōhei, Masumi Sugawara, Tsunekichi Dazai, and Yukinori Kanda. J. Phys. Soc. Japan 15, 1909-12(1960) Nov. (In English)

An investigation of the decay scheme of K^{44} was made with anthracene and 5 × 5 in. NaI(Tl) scintillation counters and coincidence techniques. In addition to the 4.91-, 3.55-,

and 2.63-Mev β rays, the following γ rays were assigned to Ca^{44}: 0.48, 0.63, 0.74, 0.90, 1.06, 1.16, 1.5, 1.74, 2.08, 2.17, 3.4, 4.4, 4.6, and 5.0 Mev. A decay scheme is proposed. (auth)

4633 ABSOLUTE CROSS SECTION OF THE REACTION $Cu^{63}(\gamma,n)Cu^{62}$ FOR LITHIUM GAMMA RAYS. Shinjiro Yasuma, Minoru Yata, Kunio Takamatsu, Akira Masaike, and Yoshiko Masuda (Kyoto Univ.). J. Phys. Soc. Japan 15, 1913-19(1960) Nov. (In English)

The cross section of the reaction $Cu^{63}(\gamma,n)Cu^{62}$ for lithium γ rays was measured in order to discover some causes of the existing discrepancy between values measured by bremsstrahlung and by nuclear γ rays. Experimental procedures used in this experiment were much improved as compared with those used in previous measurements performed for the same purpose. The results were as follows: $\sigma_{Li-\gamma} = 62 \pm 4$ mb for lithium γ rays, and $\sigma_{17.6} = 76 \pm 5$ mb for 17.6 Mev γ rays. This value is about 30% lower than the average cross section value determined by the photon difference method in several bremsstrahlung experiments. Therefore, it is suggested that the modified spectrum method proposed by Penfold and Leiss might eliminate not only the above-mentioned discrepancy but also the discrepancy between theoretical and experimental values in the form $\sigma_{-2} \equiv \int \sigma E^{-2} dE$, as pointed out by Levinger. (auth)

4634 TOTAL CROSS SECTIONS OF CARBON, OXYGEN, FLUORINE AND THORIUM FOR FAST NEUTRONS. Kineo Tsukada and Takayoshi Fuse (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan 15, 1994-2000 (1960) Nov. (In English)

The neutron total cross sections of carbon, oxygen, fluorine, and thorium were measured in the energy range of 3.3 to 5.0 Mev. Measurements were made with a good-geometry arrangement and an energy resolution of about 20 kev, using a neutron detector that had a high efficiency and a good characteristic for γ-ray discrimination. For carbon, oxygen, and fluorine, several resonances in the cross sections were analyzed to give spin assignments. For thorium, a giant resonance was observed at 4.2 ± 0.2 Mev. (auth)

4635 CHARGE DISTRIBUTION IN NUCLEI AND ENERGY LEVELS OF μ MESONIC ATOMS. G. E. Pustovalov and M. S. Krechko (Moscow State Univ.). Nuclear Phys. 19, 337-45(1960) Nov. (1). (In English)

The $2P_{\frac{1}{2}} \rightarrow 1S_{\frac{1}{2}}$ transition energies of μ mesonic atoms were calculated using Hofstadter's nuclear charge distribution. Numerical solutions of the Schroedinger equation for μ-mesonic atoms for uniform charge distribution inside a sphere of radius R_0 were used as zero-order approximation. Corrections due to modifications of uniform charge distribution and relativistic effects were taken into account by perturbation theory. It is shown that the trapezoidal and the smoothed uniform (Fermi type) models, which are equivalent for electron scattering, are not equivalent for the determination of the $2P_{\frac{1}{2}} \rightarrow 1S_{\frac{1}{2}}$ transition energy of μ-mesonic atoms. Agreement between the experimental transition energies and those calculated for the smoothed uniform model was satisfactory for heavy μ-mesonic atoms. As for light mesonic atoms the value, r_β, occurring in the formula for the uniform equivalent model radius $R_{eff} = r_\beta A_{\frac{1}{2}} \times 10^{-13}$ cm and determined from the experimental transition energy values of μ-mesonic atoms proved to be smaller than that obtained from electron scattering. (auth)

4636 DIRECT PROCESSES AND COLLECTIVE EFFECTS IN HIGH ENERGY PROTON INDUCED FISSION. H. Faissner (European Organization for Nuclear Research, Geneva) and H. Schneider. Nuclear Phys. 19, 346-65(1960) Nov. (1). (In English)

Nuclear emulsions loaded with thorium were exposed to the external 600-Mev proton beam of the CERN synchrocyclotron. For each fission event both ranges, a characteristic angle relative to the proton beam and the angle between the two fragments, were measured. From these data, under certain assumptions, the longitudinal momentum imparted to the fissioning nucleus was computed. The distribution of momentum transfers obtained fell off exponentially toward higher values. Its maximum was estimated to lie around 170 Mev/c. At momentum transfers above 300 Mev/c the light fragment was emitted preferentially in the forward direction. This indicated the existence of a direct fast-fission mode. The fore-aft asymmetry was largest for fissions almost parallel to the proton beam; it increased with increasing momentum transfer. The range distribution was symmetric. Qualitatively the fast fission may be described as a deformation of a viscous liquid drop by the fast cascade. At momentum transfers below 300 Mev/c there was no significant fore-aft asymmetry. The angular distribution, instead, was peaked around 90° to the primary direction. It can be represented by $1 + \alpha \sin^2 \theta$ with $\alpha = 0.64 \pm 0.10$. The range distribution had an asymmetric component. Angular anisotropy and mass asymmetry were consistent with the model of I. Halpern who assumed a collective rotation initiated by the capture of slow secondary nucleons. (auth)

4637 FORE-AFT YIELDS OF FRAGMENTS FROM 14-MEV NEUTRON-INDUCED FISSION. R. B. Leachman and George P. Ford (Los Alamos Scientific Lab., N. Mex.). Nuclear Phys. 19, 366-9(1960) Nov. (1). (In English)

The yield of Zr^{97} and Ba^{139} fission fragments in the direction of 14-Mev neutrons inducing fission of Np^{237} and U^{235} was measured relative to the yield in the opposite direction. The fore-aft isotropy found from these measurements agrees with the compound nucleus theory of fission. (auth)

4638 L TO K CAPTURE RATIO IN THE DECAY OF Ge^{68}. M. K. Ramaswamy (Ohio State Univ., Columbus). Nuclear Phys. 19, 377-9(1960) Nov. (1). (In English)

The L to K capture ratio in the decay of 270-day Ge^{68} was determined by comparing the number of K x rays emitted with the amount of annihilation radiation emitted in the decay of 68-min Ga^{68}. This led to a L/K ratio of 0.12 ± 0.07 in good agreement with theory. (auth)

4639 INVESTIGATION ON THE DECAY SCHEME OF ThC(Bi^{212}). M. Giannini, D. Prosperi, and S. Sciuti (Comitato Nazionale per le Ricerche Nucleari, Rome; Istituto Nazionale Fisica Nucleare; Rome and Università, Rome). Nuclear Phys. 19, 380-8(1960) Nov. (1). (In English)

The γ rays emitted in the β decay of Bi^{212} were investigated by means of α-γ, α-γ-γ, and γ-γ-γ coincidences. New γ rays of 0.13 and 0.19 Mev were found. The existence of 0.78- and 0.95-Mev transitions, recently reported, was confirmed, while no evidence of 1.3-, 1.8-, and 2.2-Mev transitions, reported by some authors, was found. An improved decay scheme of Bi^{212} is given. By means of semi-empirical calculations the spin and parity of the first excited level (0.73 Mev) was found to be 2^+ as expected. (auth)

4640 DECAY SCHEME OF Tb^{152}. K. S. Toth, O. B. Nielsen, and O. Skilbreid (Univ. of Copenhagen). Nuclear Phys. 19, 389-99(1960) Nov. (1). (In English)

The decay scheme $Tb^{152} \rightarrow Gd^{152}$ was investigated with sources prepared in an isotope separator. In addition to obtaining γ-ray and conversion electron spectra, $\gamma-\gamma$ and $e-\gamma$ coincidence measurements were carried out. A disintegration scheme was established which includes all transitions in Gd^{152} reported in earlier Eu^{152} β-decay studies. In addition, four new transitions which establish two excited levels in Gd^{152} were observed. One of these was a 0^+ state at 1047 kev and the other, at 929 kev, had probably spin 2^+. The 0^+ state decays with two monopole transitions to lower 0^+ states, and the transition from the 929-kev level to the 344-kev first excited level, seems to contain a considerable E0 admixture. The two new levels are tentatively interpreted as members of a three-phonon quintet. (auth)

4641 COULOMB EXCITATION OF THE FIRST LEVELS OF SPHERICAL EVEN NUCLEI BY MULTIPLY CHARGED IONS. D. S. Andreyev, A. P. Grinberg, K. I. Erokhina, and I. Kh. Lemberg (Leningrad Inst. of Physics and Tech.). Nuclear Phys. 19, 400-25(1960) Nov. (1). (In English)

The Coulomb excitation of the first excited levels in the nuclei of Ne^{20}, Ne^{22}, Mg^{24}, Si^{28}, Ti^{46}, Ti^{48}, Cr^{54}, Fe^{58}, Ni^{58}, Ni^{60}, Ni^{62}, Ni^{64}, $Zn^{64+66+68}$, Se^{76}, Se^{78}, Se^{80}, Se^{82}, and Zr^{92+94} was investigated by means of the cyclotron-accelerated multiply charged ions of $N^{14;3+}$ (E = 16.3 Mev), $N^{14;3+}$ (26 and 36 Mev), $O^{16;4+}$ (18.2 Mev), $Ne^{20;4+}$ (23.1 and 27.9 Mev), and $Ne^{22;4+}$ (25.2 Mev). In the first two cases the nuclei investigated were present not in the target, but in the incident particles beam. The lifetime of the first excited level was determined for all above-mentioned nuclei. Merits and difficulties in using multiply charged ions for the investigation of Coulomb excitation are discussed. (auth)

4642 NUCLEAR RESONANCE SCATTERING OF BREMSSTRAHLUNG. E. C. Booth (Boston Univ.). Nuclear Phys. 19, 426-35(1960) Nov. (1). (In English)

Nuclear resonance scattering of bremsstrahlung was observed in six cases of light to medium weight nuclei. The results agreed with previous measurements for the known cases. Mean lifetimes not previously reported are F^{19}, P^{31}, and Cu^{65}. Values of 0.5 ± 0.3, 3.4 ± 1.5, and 3.3 ± 1.5 τ/g (10^{-13} sec), respectively, were obtained for these isotopes. (auth)

4643 THERMAL AND RESONANCE NEUTRON CAPTURE GAMMA RAYS FROM Nd^{144} AND Nd^{146}. J. E. Draper and R. L. Hickok (Yale Univ., New Haven). Nuclear Phys. 19, 436-41(1960) Nov. (1). (In English)

A number of neutron capture γ rays following thermal and resonance neutron capture forming Nd^{144} and Nd^{146} were investigated in the γ-ray energy range below 1 Mev. Absolute intensities and isotopic assignments are reported. (auth)

4644 THE OBSERVATION OF $p'-\gamma$ ANGULAR CORRELATION AT A NUCLEAR RESONANCE. H. Yoshiki and N. M. Nikolic (Columbia Univ., New York). Nuclear Phys. 19, 442-7(1960) Nov. (1). (In English)

The $p'-\gamma$ angular correlation in the $C^{12}(p, p'\gamma)C^{12}$ reaction was measured on nuclear resonances between 5.3 and 6.1 Mev of incident proton energy. The excitation curve of this reaction showed a weak resonance at 5.69 Mev, which corresponded to an excitation of 7.17 Mev in N^{13}. The correlation measurements indicated a large discrepancy from the compound theory on the 5.93-Mev resonance. (auth)

4645 GAMMA RAYS FROM THE INTERACTION OF 14-MEV NEUTRONS WITH CARBON. J. Benveniste, A. C. Mitchell, C. D. Schrader, and J. H. Zenger (Univ. of California, Livermore). Nuclear Phys. 19, 448-52(1960) Nov. (1). (In English) (UCRL-5820)

The cross section for the $C^{12}(n, n')C^{12*} \rightarrow C^{12} + \gamma$ (4.43 Mev) reaction was measured near 14 Mev by detecting the γ rays at scattering angles of 30 to 150°. A time-of-flight technique was used to distinguish the γ rays from the high neutron background. A least-squares fit to the data gives $\sigma(\theta) = (13.3 \pm 0.6) + (40.0 \pm 4.7)\cos^2\theta - (34.1 \pm 5.1)\cos^4\theta$ for the angular distribution. The integrated cross section is $\sigma_{n,n'\gamma} = 249 \pm 28$ mb. (auth)

4646 PHOTOPROTONS FROM Cs AND I. R. B. Taylor (Australian National Univ., Canberra). Nuclear Phys. 19, 453-60(1960) Nov. (1). (In English)

A study was made of photoprotons emitted from Cs and I by irradiating a thin CsI(Tl) crystal with a bremsstrahlung beam and detecting the protons in the same crystal. The photoproton spectra for different bremsstrahlung end point energies all showed a broad peak at 8 Mev after correcting for "escape" protons. The proton yield was also measured and a peak cross section of 18 ± 2 mb found at 25 Mev while the integrated cross section to 32 Mev was measured as 136 ± 30 · Mev · mb. (auth)

4647 ROTARY SPIN ECHOES. I. Solomon (Centre d'Etudes Nucléaires, Saclay, France). Phys. Rev. Letters 2, 301-2(1959) Apr. 1. (CEA-1244)

Torrey has observed the free precession of nuclear spins around an r-f field H_1, fixed in a frame rotating at the Larmor frequency $\omega_0 = \gamma H_0$ around a large direct-current magnetic field H_0. He showed that for an H_1 much larger than inhomogeneity of H_0, the latter has a negligible effect on the decay of the spin magnetization which is mainly due to the inhomogeneity of H_1. A method is given for overcoming the inhomogeneity of H_1 by production of echoes in the rotating frame ("rotary echoes"). These echoes are obtained by a 180° phase shift at $t = \tau$ on the r-f field so that H_1, is suddenly reversed, producing a refocusing of the magnetization vectors at the time $t = 2\tau$. The rotary echoes so obtained are very similar to the usual spin-echoes; however, some specific features make them particularly suitable for the measurement of long relaxation times. (auth)

4648 ON THE INELASTICALLY SCATTERED PROTON AND THE DIPOLE γ-ABSORPTION. Yoshiyuki Sakamoto (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto) 24, 81-96(1960) July. (In English)

The energy spectra and the angular distributions of the protons inelastically scattered from the levels in the dipole giant γ-resonance region are investigated by taking into account the nuclear interaction, as well as the Coulomb interaction between the incident proton and the nucleons in the target nucleus. The calculated and experimental results for some nuclei are compared. It is pointed out that, as the results of nuclear interactions, the spin flip parts of the target nucleons in the nucleus play an important role. Based on the fair agreement of the calculated results with observed ones, it is proposed that the measurements of (p-p') scattering provide a powerful tool to investigate the dipole giant γ-resonance, and that the measurements give an effective way to studying the nuclear reduced matrix elements. (auth)

4649 GROUND STATES OF Ca ISOTOPES. Toshiya Komoda (Tokyo Inst. of Tech.). Progr. Theoret. Phys. (Kyoto) 24, 201-9(1960) July. (In English)

The properties of the ground states, the binding energies (pairing energies), and magnetic moment of the isotopes Ca^{42}, Ca^{43}, and Ca^{44} are studied from the standpoint of configuration mixing. All the states with one- and two-particle excitations of $f_{7/2}$ or $p_{3/2}$ particle are mixed with the main configuration $f_{7/2}^{n}$ J. The calculated values of the pairing energies and magnetic moment are in agreement with the experimental values if two-body interaction with the Rosenfeld spin mixture is used for the interaction between nucleons in the unfilled shell. (auth)

4650 COMPOSITION OF THE SECONDARY PARTICLES FROM Cu TARGET BOMBARDED BY 6.2 Bev PROTON BEAM. Nyong D. Kwon (Univ. of Bristol, Eng.). Seoul Univ. J. 9, 1-7(1959) Dec. (In English)

The composition of p, d, t, He^3 and He^4 was examined in emulsions exposed to secondary particles of 432 Mev/c constant momentum ejected from a copper target that was bombarded by a 6.2 Bev proton beam. The ratio He^3/He^4 was compared simultaneously with the results for other targets and meteorites. (auth)

4651 ON THE PARITY OF THE 441 kev $Li^7(p,\gamma)Be^8$ RESONANCE. Lennart Simons (Univ. of Helsinki). Soc. Sci. Fennica, Commentationes Phys.-Math. 24, No. 13, 1-14(1960). (In English)

The 441-kev resonance level in the reaction $Li^7(p,\gamma)Be^8$ was previously assigned J = 1 and odd parity, but the results of certain scattering experiments favor J = 1 and even parity. It is shown that the assignment 1^+ is inadequate and that the experimental value for $W(E_p, 15°)/W(E_p, 145°)$ might be explained. Calculations based on the assumption that one or several levels of opposite parity interfere yield an interference term that is too small. The experimental value for $W(E_p, 15°)/W(E_p, 145°)$ can very well be explained if the 441 kev level is assigned J = 1 and odd parity while one or several levels of opposite parity and the spin values 1 or 2 interfere. The spin value 1 will then yield a better fit to the angular distribution of the yield function $W(E_p, \Theta)$. (auth)

Particle Accelerators

4652 (AERE-R-3475) AN ACHROMATIC INFLECTOR SYSTEM FOR NIMROD. R. Billinge. United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England. Sept. 1960. 21p. BIS.

The need for achromatic inflection into Nimrod is outlined and the fundamental design of a suitable arrangement of four magnets followed by an electrostatic element is described. (auth)

4653 (BNL-5040) UTILIZATION OF EXPERIMENTAL MAGNET POWER SUPPLIES. W. W. Merkle (Brookhaven National Lab., Upton, N. Y.). Sept. 6, 1960. 2p. OTS.

4654 (MSUCP-4) COMPUTER PROGRAM FOR TRACKING OF LINEAR CYCLOTRON ORBITS. D. A. Johnson and H. G. Blosser (Michigan State Univ., East Lansing). Oct. 1960. 21p. CYCLOTRON PROJECT. Contract AT(11-1)-872. OTS.

A computer routine for the fast tracking of orbits in the intermediate radius region of sector focused cyclotrons is described. Input to the routine consists of a table of equilibrium orbit properties including linear oscillation results. The routine interpolates in the table to obtain linear transformation matrices at arbitrary energies and tracks the particle motion by successively applying the appropriate transformations. Accuracy with respect to spatial coordinates directly reflects the degree of linearity of the fields; 1 in 10^4 agreement with orbit integrations is common in the intermediate radius region. (auth)

4655 (NP-9392) THE ISOCHRONOUS CYCLOTRON (thesis). Khoe Kong Tat. Delft, Netherlands. Technische Hogeschool. 1960. 91p.

A brief account of particle dynamics in an azimuthally periodic magnetic field is given and the condition for isochronism is determined. Methods are given for calculations of the frequency of the horizontal and vertical betatron oscillations. An analysis of magnet design, measurements of the field in the horizontal plane of symmetry of the magnet, and estimates of the practical tolerances of the field and the frequency of the accelerating voltage in order to avoid serious phase slip are discussed. The effects of perturbations and nonlinear terms in the equation of motion are treated. Parameters are computed for 12- and 200-Mev cyclotrons. (W.D.M.)

4656 (UCRL-9387) BEFCYF AND DBDT: IBM 704 CODES FOR PREPARING INPUT FOR BEVATRON ORBIT CODE (BOC). C. Gerald Gardner (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 30, 1960. 23p. Contract W-7405-eng-48. OTS.

Two IBM-704 codes are presented which are auxiliary to the Bevatron orbit code BOC. The first, BEFCYF, interpolates among tabulated values of the median-plane magnetic flux density of the Bevatron to produce an equivalent array of values in a form appropriate to BOC. The second, DBDT, produces azimuthal derivatives of the fields produced by BEFCYF. The internal operation of BEFCYF and DBDT is described, and instructions for their execution are given. (auth)

4657 (ZEK-DOS-1) GAMMADOSISLEISTUNGS- UND NEUTRONENFLUSSMESSUNGEN AM ZYKLOTRON. (Gamma Dose Output and Neutron Flux Measurements from a Cyclotron). W. Rossbander (Germany. Zentralinstitut für Kernphysik, Dresden). Nov. 1959. 27p.

The distribution of the γ and neutron dose rates around the working cyclotron was measured by means of an ionization chamber and a scintillation counter. By moving the target along a radius into the accelerator chamber, the energy of the bombarding H_2^+ ions could be varied between 8.5 and 14 Mev. The ion current was varied between 5 and 60 μa. For a copper target the γ and neutron dose rates are proportional to each other independently of the ion current, ion energy, and position of the detector. The relative spatial distribution of the dose rates (excluding the areas in the immediate vicinity of the cyclotron magnet) is independent of the ion current and ion energy. It is therefore possible to predict γ and neutron dose rates for any point around the machine by use of a single monitor in a fixed position. (auth)

4658 VARIABLE-SLOPE PULSE LINE FOR SYNCHROTRON INJECTOR. D. Kenneth Wells and Rudin Johnson (Univ. of California, Berkeley). Rev. Sci. Instr. 31, 942-3(1960) Sept. (UCRL-9086).

An injector pulse-forming network for the 300-Mev synchrotron at the University of California was developed which can be adjusted to produce a pulse to match the ac-

ceptance energy of the machine at any energy. This device and a method to determine the acceptance energy curve are described. (auth)

4659 MODIFICATION OF AN ENERGY MODULATOR FOR PARTICLE ACCELERATORS. G. I. Harris, L. Kasturi Rangan, R. Stump, and L. W. Seagondollar (Univ. of Kansas, Lawrence). Rev. Sci. Instr. 31, 995(1960) Sept.

The energy modulator for particle accelerators devised by Cranberg et al. with a function sampler to label the pulses from a bombardment reaction for a multichannel analyzer was adapted to study γ-ray yield curves where the resonances are small, sharp, and close together. Some simplifications were made in the modulator together with major changes in the function sampler. The modulated pulses are fed through a cathode follower to the input of a linear amplifier feeding a 256-channel analyzer. (D.L.C.)

Plasma Physics and Thermonuclear Processes

4660 (AD-236324) MAGNETOPLASMA EFFECTS IN SOLIDS. Benjamin Lax. Massachusetts Inst. of Tech., Lexington. Lincoln Lab. Apr. 17, 1960. 31p. Contract AF19(604)-5200.

Various phenomena involving the behavior of plasma in a solid in the presence of a magnetic field are described. Each phenomenon in one form or another reflected the band properties of the semiconductor or metal being studied. (C.J.G.)

4661 (AEDC-TN-60-112) PERFORMANCE OF A D-C ARC-EXCITED PLASMA GENERATOR. W. K. McGregor, J. J. Ehrlich, and M. T. Dooley. Arnold Engineering Development Center, Tullahoma, Tenn. May 1960. 48p. ARO Project No. 106927. Contract AF40(600)-800.

A d-c arc-excited plasma generator is described. The voltage-vs.-current relationship at different pressures is examined in the light of previous work on simple enclosed arcs. Also an energy balance is presented from which the enthalpy increase of the gas and the energy-conversion efficiency is determined. For this generator the arc voltage ranged from 30 to 100 volts, the current ranged from 60 to 1000 amp, and the chamber pressure was adjusted between 1.1 and 2.4 atm. Power inputs of from 2 to 60 kw to 0.0025 to 0.01 kg sec of argon produced enthalpy rises of from 50 to 1000 kcal/kgm with efficiencies in the range of 65 to 90%. Data are reported for both argon and helium used as the working gas. A study of gas contamination due to electrode erosion is also presented; the percentage by weight of contamination at normal operating conditions is shown to be less than 0.05% using tungsten and carbon electrodes and 0.003% using tungsten and copper electrodes. (auth)

4662 (AERE-R-3260) THE USE OF SUBMILLIMETRE WAVES FOR STUDYING HIGH DENSITY PLASMAS. S. M. Hamberger. United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England. May 1960. 41p. BIS.

The possibility of using microwave techniques to study a plasma of 10^{15} to 10^{17} cm^{-3} density is discussed. The generation, detection, and control of the corresponding wavelength range, 100 to 1000 μ, are discussed. The application, operation, and performance of detectors of submillimeter radiation are reviewed. 105 references. (C.J.G.)

4663 (AFCRC-TN-60-137) THE IMPORTANCE OF THE FOURTH STATE OF MATTER TO THE MISSION OF THE AIR FORCE. Lawrence C. Mansur. Air Force Cambridge Research Center. Electronic Material Sciences Lab., Bedford, Mass. Jan. 1960. 20p. Projects 5634 and 4619.

Paper presented at the Sixth Annual ARDC Science and Engineering Symposium, October 1-2, 1959, Washington, D. C.

A discussion is given of the reasons for the intense interest in plasma or gaseous physics. A brief résumé of the history since Langmuir is presented. The physical and electrical characteristics are discussed as are the proposed and existing uses of a plasma as a power generator, a generator of electromagnetic radiation, a material, an electronic device, and a sometimes helpful and sometimes hindering environment. (auth)

4664 (AFCRC-TN-60-353) A STUDY OF CIRCULARLY BOUNDED AND INFINITELY EXTENDED MEDIA INCLUDING THE INFLUENCE OF COLLISIONS. Research Report No. 2 on OSCILLATORY PROPERTIES OF GYROMAGNETIC ELECTRONIC COLD PLASMAS WITH DRIFT MOTION. K. Hans B. Wilhelmsson. Chalmers Tekniska Högskola, Goteborg. Forskningslaboratorium för Elektronik. June 1959. 47p. Contract AF61(052)-159, Report No. 4, (AD-236514).

An earlier treatment of the problem of two interpenetrating electronic media which neglected the collisional effects, is extended by considering the influence of collisions. The collisional effects are described by means of effective collisional frequencies which are assumed to be different for the drifting electrons and for the electrons without drift motion. Special attention is paid to the influence of the drift terms and of relativistic corrections. It is concluded that although the collisions affect the dispersion relations, the same types of waves will be excited under the same excitation conditions as in the absence of collisions. (W.L.H.)

4665 (AFCRC-TN-60-374) A BEAM-GENERATED BEAM-PLASMA SYSTEM. First Scientific Report. C. C. Wang, J. E. Hopson, L. P. Levine, and E. W. Cheatham. Sperry Gyroscope Co. Electronic Tube Div., Great Neck, N. Y. Mar. 1960. 63p. Contract AF19(604)-5555. (NA-8210-8191-1; AD-238105).

The minimum pressure condition for plasma generation, which is the result of directing an electron beam through a residual gas (hydrogen in this study) along magnetic field lines, was theoretically predicted and experimentally verified. For pressures greater than the minimum pressure, the equilibrium plasma density was analyzed. Plasma growth greater than that expected from collisions of primary electrons with residual gas atoms was found; diffusion-controlled breakdown caused by a microwave generation process of the system explains this growth. Microwave interaction of the beam-generated plasma circuit with the primary beam is exhibited as a velocity modulation of the beam. Experiments show a discrete bandwidth noise spectrum; theoretically discrete frequency oscillations over a prescribed bandwidth should be produced. Plasma circuit characteristics are not independent of microwave power level as was assumed in the theory; the microwave power generated is apparently absorbed by the plasma. The plasma, therefore, is unstable. (auth)

4666 (AFCRC-TR-60-108(Vol. 1)) PROCEEDINGS OF SYMPOSIUM ON THE PLASMA SHEATH, [BOSTON],

7-9 DECEMBER 1959. VOLUME I. Air Force Cambridge Research Center, Mass. 228p. (AD-236932).

The plasma sheath is defined as an envelope of ionized gas that surrounds a space vehicle as it reenters the atmosphere at hypersonic velocities. The interest of the symposium was slanted to the effect of these ionized flow fields on transmission, reception, and diffraction of radio waves. Separate abstracts were prepared for four of the eight papers. (W.D.M.)

4667 (AFCRC-TR-60-108(Vol. 1)(Paper 2)) RELAXATION PHENOMENA IN SHOCK FRONTS—A REVIEW. I. P. Shkarofsky, T. W. Johnston, and M. P. Bachynski. RCA Victor Co., Ltd. Research Labs., Montreal. Paper 2 of PROCEEDINGS OF SYMPOSIUM ON PLASMA SHEATH, [BOSTON], DECEMBER 7-9, 1959. 61p.

For aerodynamic phenomena occurring at temperatures in excess of 1000°K, a great number of collisions between the constituent particles of a gas are required in order that thermal equilibrium be established. Under these conditions, relaxation times can be associated with the distribution of the internal energy of the gas into the various energy states. The phenomena occurring in a shock front from the start of the shock to the point of thermal equilibrium behind the shock is reviewed. Chemical reactions at high velocities, temperature variations across a shock front, mechanisms of energy transfer, and effects of air flow rate on relaxation are considered. A comparison of a plasma set up by a hot gas and one created by a gas discharge is given. The distribution of energy into translational, rotational, and electronic states as well as dissociation and ionization are discussed in detail. Some regard is given to relaxation rates, collision processes, ionization onset point, and radiative relaxation. (auth)

4668 (AFCRC-TR-60-108(Vol. 1)(Paper 3)) RADIO FREQUENCY RADIATION FROM HYPERSONIC PLASMAS WITH IMPRESSED OSCILLATING ELECTRIC FIELDS. C. A. Roberts. Douglas Aircraft Co., Inc., [Long Beach, Calif]. Paper 3 of PROCEEDINGS OF SYMPOSIUM ON PLASMA SHEATH, [BOSTON], DECEMBER 7-9, 1959. 33p.

The total (integrated frequency distribution) radiated power from a plasma with an impressed electric field ($E \cos \omega t$) is calculated taking into account only the semi-classical bremsstrahlung due to electron-ion encounters. The calculation is made by using the impulse approximation with the lower limit on the impact parameter taken as the DeBroglie wavelength of the electron. The electron velocities are then averaged by using the appropriate non-equilibrium velocity distribution. Results are given for various conditions that might be encountered in hypersonic plasmas. The radiation frequency spectrum of the plasma in the radio-frequency range for a zero field is examined by a Fourier analysis of the acceleration using the impulse approximation. In order to determine the validity of the approximation, a comparison is made between the zero field radiation spectrum from an ionized gas calculated by using the impulse approximation with a cutoff at the DeBroglie wavelength and the spectrum from the exact (dipole approximation) calculation for low (radio) frequencies. (auth)

4669 (AFCRC-TR-60-108(Vol. 1)(Paper 4)) PROPAGATION OF ELECTROMAGNETIC WAVES IN A PLASMA WITH AN INHOMOGENEOUS ELECTRON DENSITY. A. J. Penico. [Sylvania Electric Products Inc., Bayside, N. Y.]. Paper 4 of PROCEEDINGS OF SYMPOSIUM ON PLASMA SHEATH, [BOSTON], DECEMBER 7-9, 1959. 11p.

A theoretical study was performed to determine the propagation characteristics of an electromagnetic wave in the presence of an isotropic, dissipative plasma whose electron density varies in the direction of propagation of the wave. In the analysis, various functional forms giving the electron density as a function of the position within the plasma were inserted into the wave equation for the medium, and exact solutions were obtained for the equation. The above-mentioned solutions are discussed from two points of view. First, their qualitative behavior for all, or nearly all, of the values of the parameters are discussed. Second, curves are shown indicating the specific behavior of the solutions for limited ranges of r-f frequency, electron-neutral particle collision frequency, initial and final electron density, and rate of variation of the electron density. Criteria are discussed for treating the electron density as slowly-varying or rapidly varying. In particular, some quarter-wavelength and half-wavelength criteria of the medium are exhibited. These criteria are discussed in relation to the problems of reflection and absorption of the waves. (auth)

4670 (AFCRC-TR-60-108(Vol. 1)(Paper 5)) PECULIAR WAVE PROPAGATION CHARACTERISTICS OF A PLASMA WITH MAGNETIC FIELD. H. Poeverlein. Air Force Cambridge Research Center. Propagation Sciences Lab., Bedford, Mass. Paper 5 of PROCEEDINGS OF SYMPOSIUM ON PLASMA SHEATH, [BOSTON], DECEMBER 7-9, 1959. 16p.

Propagation of electromagnetic waves in a plasma is very peculiar in cases of the presence of an intense magnetic field. The two magnetoionic modes have refractive indices of, or in the order of, unity. One of them is perfectly guided along the magnetic force lines. The plasma appears homogeneous and nonabsorbing, regardless of its actual data. The propagation characteristics are theoretically derived from the conductivity tensor of the plasma. The magnetic field suppresses the conductivity components normal to it. The plasma frequency is assumed to be well above the frequency of the waves. No consideration is given to ion motions and pressure gradients. (auth)

4671 (LAMS-2471) DYNAMIC SHEATH IN AN AXIAL MAGNETIC FIELD. F. L. Ribe (Los Alamos Scientific Lab., N. Mex.). Jan. 20, 1960. 10p. Contract W-7405-eng-36. OTS.

The streak-camera photographs of the Scylla discharge show a thin luminous structure imploding radially inward at the beginning of the second and third half-cycles which is suggestive of a dynamic plasma sheath. An analysis of the motion of a plasma sheath in which the plasma particles are projected elastically ahead of the sheath is made, assigning pertinent parameters those values applicable to the Scylla experiment. It is found that the motion of the observed luminosity is well accounted for by the sheath model. Scaling considerations show that, for a given voltage applied to the B_z coil, the sheath speed is nearly independent of the ratio of source and coil inductances. (auth)

4672 (LAMS-2473) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING SEPTEMBER 20, 1960. Los Alamos Scientific Lab., N. Mex. Oct. 1960. 17p. Contract W-7405-eng-36. OTS.

Construction details, efficiency, fuel modifications, triple cell assembly, pin temperature determination, and reactor flux for in-pile tests of the plasma thermocouple in the Omega West Reactor are discussed. Work on electrical

conductivity and emission spectra of cesium plasma is reviewed. Plasma cell development studies are reported on in terms of isothermal cells, fuel-pin development, theoretical study of an isothermal plasma, electron emission from plutonium carbide, plasma thermocouple studies, and fabrication techniques. (For preceding period see LAMS-2447.) (W.D.M.)

4673 (LMSD-288032) THE COLLAPSE OF AN AXIALLY SYMMETRICAL PINCH. S. Gartenhaus and L. M. Tannenwald (Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.). Oct. 15, 1959. 24p.

The equation of motion of an axially symmetric pinch surface is derived according to the Rosenbluth independent particle model. Exact solutions are found in parametric form for a class of boundary conditions. In the limit where the pinch may be considered as driven by an external circuit, it is shown that all parameters that describe the driving circuit may be absorbed into the definition of a new time scale. Numerical results that compare the collapse of an axially symmetric pinch surface with that of a set of right circular cylinders are presented, and these show that significant differences occur. An estimate of the magnitude of the axial thrust expected from the collapse of an axially symmetric body of plasma is given. The relative importance of various parameters as they affect propulsion is briefly discussed. (auth)

4674 (MATT-46) TILTING CONFINING FIELD COILS FOR THE C STELLERATOR. U. Christensen. Princeton Univ., N. J. Project Matterhorn. July 5, 1960. 29p. Contract AT(30-1)-1238. OTS.

The tilt angles of the confining field coils of the C Stellarator were calculated for stages I and II at various levels of bulge-coil current. (C.J.G.)

4675 (MATT-Q-11) QUARTERLY REPORT COVERING THE PERIOD APRIL 1–JUNE 30, 1960. Princeton Univ., N. J. Project Matterhorn. July 1960. 36p. Contract AT(30-1)-1238. OTS.

Continuing studies on confinement in B-1 and B-3 indicated the following results: The pump-out rate during the ionization stage of ohmic heating was analyzed quantitatively, using the assumption of a constant rate of charged-particle production. These calculations indicated that the confinement time varies roughly linearly with the magnetic field. A similar analysis of data obtained with restricted apertures suggests that the confinement time varies directly as the cross-sectional area of the aperture or current channel. These conclusions are still preliminary. Density measurements in a partially ionized helium plasma, after ohmic heating, show that after an initial rapid drop the electron density decays at a rate which is (1) exponential over more than two orders of magnitude, (2) independent of aperture radius and magnetic field, (3) proportional to the square root of the neutral pressure, with a time constant of about 1 msec at 1 μ. Absolute measurements of the total light radiated show that one photon appears for every six electrons disappearing; this ratio is apparently constant for all conditions. Evidently pump-out virtually ceases under these conditions, and the electrons disappear by some recombination process. Measures of synchrotron radiation indicate that runaway electrons disappear when the plasma current is within the range from 11 to 14% of the Kruskal limit. The m = 2 kink instability is predicted for currents between 8 and 17% of the Kruskal limit. This seems to be the first positive identification of the m = 2 instability in a stellarator. Fabrication and installation of equipment for Model C are proceeding on the schedule as revised 3 months ago, with operation scheduled for early 1961. (For preceding period see MATT-Q-10.) (auth)

4676 (NP-9062) LECTURES ON PLASMA PHYSICS. LECTURES 1 THROUGH 8. W. B. Thompson. United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England. [1959?]. 98p.

These lectures (1 through 8) may be further identified as TP/49, 50, 63, 64, 65, 66, 67, and 68, respectively.

Eight lectures are presented on introductory plasma physics covering magnetohydrodynamics, magnetohydrodynamic stability, particle motions, kinetic theory, and controlled thermonuclear research. (W.D.M.)

4677 (PPL-TR-60-3) POWER SUPPLY DESIGN PARAMETER STUDY FOR ELECTROMAGNETIC DETONATIONS (PHASE I). K. M. Foreman (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). Aug. 31, 1960. 22p. Contract AF49(638)-552. (AFOSR-TN-60-1198).

The characteristics of an electric power supply for electromagnetically induced detonations are presented. A parametric study of circuit constants for a single simple R-L-C series circuit shows that this type of power supply is inadequate to provide for all requirements of a propulsion device. However, a suitable pulse of current for laboratory demonstration purposes can be achieved with the following typical circuit constants: $L = 10^{-8}$ henries, $C = 3 \times 10^{-5}$ farads, and $R = 10^{-2}$ ohms. (auth)

4678 (PPL-TR-60-7) GENERALIZED PINCH DYNAMICS IN NONDIMENSIONAL FORM. William J. Guman (Republic Aviation Corp. Plasma Propulsion Lab., Farmingdale, N. Y.). May 1960. 15p. Contract Nonr-2851(00).

The equations of the "snow-plow" pinch analysis for a pinch occurring in a fluid with initial velocity and density distributions were put into nondimensional form and reduced to a set of three nonlinear differential equations that must be solved simultaneously. The electrode nozzle geometry selected converts radial pinch motion to an axial motion. (auth)

4679 (TID-6829) PROGRAMME AND ABSTRACTS OF PAPERS. Second Annual Meeting of the Division of Plasma Physics of the American Physical Society, [held at] Gatlinburg, Tennessee, November 2-5, 1960. American Physical Society, New York and Oak Ridge National Lab., Tenn. 89p. OTS.

The program and abstracts of papers are given. Sessions were held on stability theory, plasma and ion production and acceleration, kinetic theory and radiation, properties of plasmas, stability theory and waves in plasma, mirrors and cusps, waves in plasma, Stellarator experiments, mirrors and orbits, and pinches and diagnostics. (W.D.M.)

4680 (UCRL-5671-T(Rev.)) FEASIBILITY STUDY OF TRANSIENT VERSION OF ASTRON THERMONUCLEAR REACTOR. PART I. C. C. Chang (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 14, 1959. Changed from OFFICIAL USE ONLY Aug. 3, 1960. 13p. OTS.

A transient version of the Astron thermonuclear reactor is proposed which would possess the same principle element of the Astron, i.e., Cristofilos' E-layer. The additional parts include an electron injection system, generators and injection systems of rotating plasma, coils for

axial and magnetic mirror fields, and a container. As soon as the E-layer is established, the deuterium plasma in two hydromagnetic homopolar devices are pushed out simultaneously by the shock coil, pass through the radial fields and generate current to pinch themselves into plasma rings. These rings are shot out right at the location of the cylindrical E-layer with supersonic speed and collide, producing a strong shock wave to convert the axial component of kinetic energy into heat. The heating process can be suddenly accelerated and the thermonuclear reaction and power may occur within a short time. Because of the strongly confined field and organized relativistic electrons with much higher energy, runaway electrons in plasma cannot be expected to seriously impair nuclear fusion. (M.C.G.)

4681 (UCRL-6077) SOME ASPECTS OF THE ECONOMICS OF FUSION REACTORS. Richard F. Post. California. Univ., Livermore. Lawrence Radiation Lab. Aug. 1960. 62p. Contract W-7405-eng-48. OTS.

Some aspects of the power balance and eventual economics of fusion reactors are considered. The discussion is specifically oriented toward a D-T mirror machine type reactor, although some of the remarks have a wider applicability. (W.D.M.)

4682 (UCRL-6084) HYDROMAGNETIC STABILITY DIAGRAMS FOR A LINEAR PINCH. Daniel Z. Freedman (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 15, 1960. 20p. Contract W-7405-eng-48. OTS.

Hydromagnetic stability diagrams for the linear pinch devices were prepared on the basis of stability criteria derived by Newcomb and Kaufman. From these diagrams the minimum and maximum plasma pressures consistent with stability may be determined as a function of the field geometry. Both the columnar and tubular pinches are treated. (auth)

4683 (UCRL-9106) CONTROLLED THERMONUCLEAR RESEARCH QUARTERLY REPORT FOR DECEMBER 1959, JANUARY, FEBRUARY 1960. California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Livermore. Lawrence Radiation Lab. Mar. 17, 1960. 122p. Contract W-7405-eng-48. OTS.

Some of the more significant accomplishments in the Pyrotron program, the Astron program, the Livermore pinch program, Berkeley plasma research, theoretical and basic experimental plasma physics, and engineering and technological development are reported. Machine calculations on ion-density build-up by energetic neutral atom injection (Alice) indicated that charge exchange between already trapped atomic ions and the incoming neutral beam results in a significantly faster increase in plasma density near the axis as long as the size of the orbit for the ion in the confining field is an appreciable fraction of the width of the injected beam. An analysis of the energy transfer from 200-kev deuterons to cold electrons (10 to 1000 ev) showed that the energy-transfer rate is appreciably less than the value predicted by the quasi-equilibrium theory. Analysis of the stability of the tubular pinch led to the conclusion that conditions for stability are much more easily satisfied in the tubular pinch than in a columnar pinch. The condition which ensures stability is that $|rB_\theta|$ is a decreasing function of r, which can be satisfied in a tubular pinch but not in a columnar pinch. A technique was developed for finding sufficient theoretical conditions for hydromagnetic stability in diffuse linear pinches and applied to the hard-core type of pinch. It is found that plasma "β's" of the order of 0.5 are compatible with hydromagnetic stability if the configuration corresponds to the "maximal force" regime. In the Table Top project, significant results are being obtained on the limits of stability for plasmas of highly anisotropic velocity distribution. Highly anisotropic conditions are produced by high magnetic-field compression ratios with low plasma density; with these conditions collision processes do not occur fast enough to maintain approximate isotropy. Experiments with plasma jets injected axially into cusp geometry under conditions which have been said to ensure a high trapping efficiency showed no evidence for trapping of the plasma, which either is immediately lost out the cusp or penetrates the stronger mirror on the far end of the cusp adjusted to a value which is predicted to prevent penetration. In related experiments on colliding plasma jets previously reported it was shown that the predicted violent interaction between colliding plasma jets does not seem to occur. A modified technique for utilizing evaporated molybdenum films in vacuum gettering was unexpectedly effective in reducing the pressure in an unbaked vacuum system to the range of 10^{-9} mm Hg. This technique was developed in the Alice project and was applied to the Table Top machine with remarkable success. The method of inductance balancing, discussed in the preceding report as a possible means of correcting the unbalanced magnetic forces in the tubular pinch that throw the plasma against the inner wall of the annular space, was tried out with very favorable results. Streak-camera pictures now show the plasma clearly remaining near the center of the annular space with no tendency to hit the walls. (For preceding period see UCRL-9002.) (W.D.M.)

4684 (UCRL-9243) CONTROLLED THERMONUCLEAR RESEARCH QUARTERLY REPORT, MARCH, APRIL, MAY 1960. California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Livermore. Lawrence Radiation Lab. June 20, 1960. 136p. Contract W-7405-eng-48. OTS.

Some of the more significant accomplishments in the Pyrotron program, Astron program, Livermore pinch program, Berkeley plasma research, theoretical and basic experimental plasma physics, and engineering and technological development are reported. A fairly complete theoretical treatment of a plasma with nonisotropic pressure confined in a mirror field was carried out. For comparison with the observation of nonisotropic instabilities produced in the Table Top machine the axial distribution of the plasma for various ratios of transverse to axial pressure components was computed. Theoretical predictions of the critical values of P/B^2 for various ratios of transverse to axial pressure components can now be compared with the experimental results obtained on the Table Top machine. Additional results were obtained on the energy transfer from energetic ions to cold electrons in a plasma. It is found that for 20-kev deuterons the rate of energy transfer to electrons from 10 ev to 1 kev temperature is appreciably less than that derived by Lyman Spitzer in "Physics of Fully Ionized Gases." These results are comparable to those described in the preceding report for 200-kev deuterons. In the Baby Alice energetic neutral atomic injection facility there is good agreement between the observed mean life (25 to 30 μsec) of the captured ions as measured by observation of the energetic neutral particles lost due to charge exchange on the background gas and that expected from the pressure of the residual gas and the charge-exchange cross section. The character and causes of r-f oscillations in the experimental Astron injection system were identified and the oscillations

were greatly suppressed. The oscillations were traced to several causes: the broad energy distribution of the electrons as initially injected, r-f modulation of the electron beam in the injector due to klystron-like oscillations in the electrode structure, and shock excitation of transverse electric modes in the beam-trapping cavity by the incoming beam pulse. The first two causes were reduced substantially by injecting electrons of very narrow energy range and by correcting the causes of oscillation in the accelerating column. Shock-excited oscillations were suppressed by introduction of radial fins near the outer wall of the cavity. The electron-beam probe apparatus for exploring the magnetic field of a linear magnetically stabilized pinch is now working reliably. Indications are that the electron beam follows the magnetic field lines "adiabatically," so that interpretation of motions of the beam spot is now possible. The apparatus is particularly well suited to the measurement of diffusion of the B_θ into the B_z field, for which preliminary observations are in progress. Further study of the output of the conical pinch plasma accelerator indicated that the average energy of the plasma deuterons is from 3000 to 100 ev, the plasma density from 10^{14} to 2×10^{15} deuterons/cm^3 for operation in the pressure range from 100 to 400 μ of D_2. The total output ranges from 10^{17} to 10^{18} deuterons per pulse and represents from 1 to 10% of the initial gas in the discharge. The output plasma velocity is found to depend upon the direction of the applied potential. If the voltage is reversed so that the output electrode is the anode, the mean output velocity is reduced to about one-half the figures given above, indicating that electrostatic as well as hydromagnetic forces play a role in the plasma propulsion in this device. Measurement of the radial current flow at the boundary of the plasma in the hydromagnetic-wave experiment demonstrated that the oscillating-current circuit is completed in the plasma and not in the wall of the tube that contains the plasma. This measurement yields the boundary condition, which has been in doubt, and in particular proves that the azimuthal magnetic field goes to zero at the boundary. These conditions can now be put into the solution for the modes that are first-order Bessel functions for the radial current with zero values at the central axis and at the wall. Higher modes can be experimentally separated from the fundamental because of differences in attenuation. With an input of about 200 kw of 9-Mc r-f power into the hydromagnetic wave in the Hothouse II plasma-heating experiment for periods of about 100 μsec, microwave measurements indicated that about 30% of the neutral gas is ionized by the r-f alone. A substantial increase in r-f power input will result from modifications now in progress. The formation time for low-pressure breakdown at 100 kv in the Homopolar IV device at magnetic field intensity of 10 to 20 kilogauss was found to be from 100 to 200 μsec. This period appears quite adequate for injecting a puff of gas and ionizing it to form a rotating plasma. The fast cusp compression of a section of a linear-discharge (moderate-pinch) column resulted in the formation of a disc of plasma in the median plane of the cusp field. The combination of a linear-discharge column with a fast-rising cusp field may provide a more valid means of studying cusp confinement of a high-β plasma than other experiments previously described. (For preceding period see UCRL-9106.) (W.D.M.)

4685 (AD-236384) COLD FUSION REACTORS AND THEIR APPLICATION FOR THE PROPULSION OF SPACE VEHICLES. O. Wolczek. Translated for Picatinny Arsenal. Feltman Research and Engineering Labs. from Raketentech. u. Raumfahrtforsch. 2, 93-6(1958). 14p.

Problems of the cold-fusion reactors which work with catalysis of nuclear reactions at low temperatures are considered. Application of a special model with linear particle acceleration to space-vehicle propulsion is discussed. (W.D.M.)

4686 (AFOSR-TN-59-872) THEORY OF THE MAGNETIC BOUNDARY LAYER. (Teoriya Magnitnogo Pogranichnogo Sloya). V. N. Žhigulev (Zigulev). Translated by William J. Rae from Doklady Akad. Nauk S.S.S.R. 124, 1001-4(1959). 6p. (AD-236059).

Examples are cited that illustrate the phenomenon that a moving plasma tends to be shielded from external magnetic fields and from electric currents that flow in it. The thickness of the shielding layer has the order $1/\sqrt{Re_m}$ for motions at large Reynolds numbers. (auth)

4687 SCATTERING OF ELECTROMAGNETIC WAVES FROM A NONDEGENERATE IONIZED GAS. Jacques Renau (Cornell Aeronautical Lab., Inc., Buffalo). J. Geophys. Research 65, 3631-40(1960) Nov.

On the basis of a derived Coulomb interaction function, which takes into account the effect of the electrons and the positive ions, a rigorous theory of electromagnetic scattering was obtained for a nondegenerate ionized gas in thermal equilibrium. Moreover, it is shown that by smearing the positive ions in the background and ignoring the background (a model used by Pines and Bohm [1952] and Akhiezer, Prokgoda, and Sitenko, [1958]) a scattering cross section incompatible with ionospheric experimental observations [Bowles, 1959] is obtained. Electromagnetic wave scattering from an ionized gas in nonlaminar flow is also considered. The analysis shows that if the operating wavelength is much smaller than the smallest eddy size, the mass motion may be neglected and the scattering will be due to the thermal source only. On the other hand, when the wavelength is much greater than the smallest eddy size, the scattering from the nonlaminar fluctuations may dominate the fluctuations from the thermal source if the intensity of turbulence is sufficiently strong. The expected frequency spectrum of the echoes from an ionized gas in turbulent motion is discussed briefly. (auth)

4688 PROPAGATION OF SHOCK WAVES IN INHOMOGENEOUS GASES. II. HYDROMAGNETIC SHOCK. Yôrô Ôno, Shirô Sakashita, and Hatuo Yamazaki (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto) 24, 155-60 (1960) July. (In English)

The propagation of a hydromagnetic shock wave in inhomogeneous magnetic field is considered. The existence of magnetic field has the effect of restraining the growth of shock strength. When the magnetic pressure is large compared with gas pressure, even the diminution of shock strength can occur. As an application, the propagation of shock wave in solar chromosphere is discussed. (auth)

4689 SHOCK WAVES IN MAGNETIC HYDRODYNAMICS. R. V. Polovin (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Uspekhi Fiz. Nauk 72, 33-52(1960) Sept. (In Russian)

A survey is made of a series of theoretical works devoted to magnetohydrodynamic shock waves. In magnetohydrodynamics, there are three forms of simple waves: Alfvén, magnetoacoustic (fast and slow), and entropy waves. Special cases of simple waves are self-similar waves; i.e., waves in which all magnetohydrodynamic quantities depend on the ratio x/t. These occur when the initial conditions do not specify a measure of length. Simple Alfvén waves propagate without distortion; simple

magnetoacoustic waves, under conditions usually met, distort in such a manner as to sharpen into shock-front discontinuities. Zemplen's theorem and its converse were shown to hold for magnetohydrodynamics. The concept of an evolutionary discontinuity is defined; it is one in which infinitesimal perturbations produce infinitesimal changes in the solution of the equations. A nonevolutionary discontinuity is unstable to splitting. The conditions for the propagation of evolutionary discontinuities were determined and led to restrictions on the relative velocities of fluid and shock wave on the two sides of the front. Several consequences of general importance are described. The incremental variations in various magnetohydrodynamic quantities produced by the passage of shock waves are examined in some detail. The problem of a uniformly moving piston in magnetic hydrodynamics is clarified by excluding solutions corresponding to nonevolutionary waves. This problem was solved fairly generally; the results are described in terms of the waves associated with the motion, the resulting fields, and the force resisting the motion. The splitting of an unstable discontinuity is considered and various features of the resulting stable waves described. (TTT)

Shielding

4690 (AD-239871) LITERATURE SURVEY OF CONCRETES FOR NUCLEAR RADIATION SHIELDING. Type C Final Report. Meldon Merrill and W. L. Cowell (Naval Civil Engineering Lab., Port Hueneme, Calif.). June 28, 1960. 32p.

A literature survey was made to determine the extent of knowledge about shielding materials used as aggregates in concrete. Information is presented on mix designs incorporating various types of heavy aggregates, available cost data relating to construction methods and aggregates, problems associated with heavy concretes during construction, and nuclear shielding properties for concretes. The use of heavy aggregates for increasing the density of concretes has been well explored by previous investigations. At present there are no materials that can compete economically with barite and iron ores. Of the iron ores, magnetite is the most popular. Of the high cross-section materials for thermal neutron absorption, boron is generally the most economical. (auth)

4691 (AERE-R-3442) GASLIT: A PROGRAMME FOR CALCULATING THE GAMMA DOSE RATE IN THE SHIELD OF A SMALL REACTOR. W. E. Acraman (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1960. 40p. BIS.

GASLIT (GAmma Shielding LIdo Type) is a program in MERCURY Autocode. It is designed to calculate the γ dose rate or the rate of heat deposition at points along the center line of a multilayer shield of a reactor due to sources in the core, at the sides of the core, and in the shield regions. "Taylor" build-up factors are used for the build-up of low energy photons. The source distribution may be expressed by a maximum of 700 values in the core, 500 at the sides of the core, and 144 mesh intervals in each of up to 30 shield regions. Lateral variation of the sources in each shield region may be allowed for by specifying the off axis source distribution with up to 40 equally spaced radial mesh intervals. (auth)

4692 (WADC-TR-59-771) MONTE CARLO CALCULATIONS OF GAMMA RAY PENETRATION. Herbert Steinberg and Raphael Aronson (TRG, Inc., Syosset, N. Y.). Aug. 1960. 191p. Project No. 7112. Contract AF33(616)-6081. OTS.

Monte Carlo codes for computing γ-ray transmission through slab and spherical shields were developed. Fractional deviations in transmitted current of above 5% were obtained for shields up to fifteen or twenty mean free paths thick by use of importance sampling. A similarity transformation enables computation of γ transmission for shields of several thicknesses at once. Results were obtained for transmission of radiation incident on plane lead slabs 2 to 12 mean free paths thick and on iron and aluminum slabs 2 to 10 mean free paths thick at angles of 0, 15, 30, 45, 60, and 75° with the normal. The transmitted energy spectrum of 8 and 10-Mev bremsstrahlung radiation incident on 4 and 6-in. lead slabs was computed. (auth)

4693 SHIELDING BETA RADIATION. T. Musialowicz and F. Wachsmann (Universität, Erlangen, Ger.). Atompraxis 6, 404-7(1960) Oct.-Nov. (In German)

One of the questions involved in shielding β rays is the amount of x radiation produced in the cover film. The ratio between the β dosage rate and the x-ray dosage rate is especially important in shielding the eyes. Since the proportion of x rays produced in the absorber increases with its atomic number, there was doubt as to the usefulness of using lenses with a higher effective atomic number in safety goggles for protection against β radiation. Calculations and empirical measurements both showed that the atomic number of the shielding material makes no difference, since even with lead the proportion of x rays is less than 0.1%. (auth)

4694 LEAD SUSPENSION FOR LOW-ENERGY RADIATION SHIELDING. Edgar A. Watts (Columbia Univ., New York). Health Phys. 4, 68-9(1960) Oct.

A lead suspension was devised which may be applied easily by brush or spray-gun to provide additional shielding for existing intermediate and low-energy x-ray tube housings, darkrooms, and radiation enclosures. The suspension forms a continuous surface, conforms to existing contours, and is capable of being finished to match existing decor. (C.H.)

4695 CAN THE NUCLEAR MANY-BODY PROBLEM BE SOLVED BY USING PERTURBATION THEORY? J. S. Levinger (Louisiana State Univ., Baton Rouge, La.). Nuclear Phys. 19, 370-6(1960) Nov. (1). (In English)

A static two-body potential of Serber exchange character with a repulsive core failed to produce saturation in first-order perturbation theory, if the core was treated as a pseudo-potential. (The order of the term was designated in a joint expansion in powers of the strength of the attractive potential and in the range of the repulsive core.) Second-order terms were estimated from the condition that saturation should be achieved at the observed density without invoking many-body forces. It was concluded that any static potential that produces saturation at about the empirical density must have substantial second-order terms of magnitude 10 Mev/particle or more. The use of a velocity-dependent two-body potential to replace the infinite repulsive core was discussed. It was found that second-order terms may be much smaller if a velocity-dependent potential is used. (auth)

4696 ABANDONMENT OF THE ASSUMPTION OF THE DISPLACEMENT INVARIANCE AND REPLACEMENT OF THE ASSUMPTION OF FIELD BY THE ASSUMPTION OF PARTICLE. Takao Tati (Kanazawa Univ.,

Japan). Progr. Theoret. Phys. (Kyoto) 24, 1-17(1960) July. (In English)

A description is given of a field theory by two parameter spaces in order to separate the two functions fulfilled by the space time, i.e., the representation of the degree of freedom of the dynamical system and the specification of the order of measurements. After the two functions of space time are separated, the assumption of the displacement invariance is abandoned and the momentum-conservation law of finite "range" is assumed. Further, the assumption of the field is replaced by the assumption of the particle. Then the domain of the applicability of theory is extended so as to be able to describe the elementary particles with finite degree of freedom. Some possible observable effects peculiar to the theory of finite degree of freedom are discussed. Some possible observable effects peculiar to the theory of finite degree of freedom are discussed. The difference between the concept of space-time distance in the present field theory and that in the new theory is mentioned. (auth)

4697 A RELATIVISTIC MODEL FOR A SHELL OF FLOWING RADIATION IN A HOMOGENEOUS UNIVERSE. P. C. Vaidya (Gujarat Univ., Ahmedabad, India) and K. B. Shah. Progr. Theoret. Phys. (Kyoto) 24, 111-25(1960) July. (In English)

Rigorous solutions of Einstein's field equations of general relativity are presented. They are found to represent the gravitational field within a shell of radiation flowing outward in a homogeneous universe. These models suggest that the effect of complete conversion of matter into radiation appears to decrease the curvature of the universe. (auth)

4698 THEORY OF MATTER WITH SUPER LIGHT VELOCITY. Sho Tanaka (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto) 24, 171-200(1960) July. (In English)

The matter with a super light velocity is treated as one possible model in the course of looking for the physical concept that will essentially govern the future theory of elementary particles. It is investigated according to the canonical quantization to what extent this matter could be reconciled to the usual particle aspect of elementary particles. Further, taking into consideration the interaction of this matter with other particles, it is attempted to quantize this matter so as to derive the Lorentz-invariant but quasi-causal S-matrix and to remove the free state of this matter from possible physical states. (auth)

4699 HIGH ENERGY LIMIT OF VERTEX FUNCTION IN QUANTUM FIELD THEORY. Seiya Aramaki (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto) 24, 210-11(1960) July. (In English)

The behavior of the vertex function at the high-energy limit was studied with the model of Lehmann et al., of a neutral pseudoscalar meson of mass μ interacting with a nucleon of mass $M > 2\mu$. It is concluded that the vertex function high-energy limit is determined by the limit of $\Delta'_F(k)$, the meson renormalized propagator. (D.L.C.)

4700 ON THE G_A/G_V RATIO IN β-DECAY. Chiaki Ihara (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto) 24, 211-13(1960) July. (In English)

The ratio of the observed axial vector coupling constant to the bare one in β decay, G_A/G_A^0, is calculated from the composite model for the pion, and the results are tabulated for scalar, tensor, and pseudoscalar coupling. (D.L.C.)

4701 POSSIBLE CORRECTIONS TO NUCLEAR MAGNETIC MOMENTS DUE TO PAIRING FORCES IN NUCLEI. [PART] I. J. Sawicki (Univ. of California, Berkeley). Progr. Theoret. Phys. (Kyoto) 24, 213-16(1960) July. (In English)

The possibility of an enhancement of the magnetic energy of an even-even nucleus in a constant magnetic field due to BCS-type pairing forces is examined with Migdal's perturbation method. The correction to the nuclear energy is found to be $\Delta E = -\Delta^2 \Sigma_\lambda (V_{\lambda\lambda})^2/(2E_\lambda^3)$ which, however, was found to be negligible for the Mg^{24} nucleus using Nilsson wave functions for the deformation parameter and the observed pairing energy for Δ. Other possible two-body force effects are discussed. (D.L.C.)

Theoretical Physics

4702 (JEN-56-DF/I-16) DIAGONALIZATION OF HAMILTONIAN. L. M. Garrido and P. Pascual (Spain. Junta de Energiá Nuclear, Madrid). 1960. 15p.

A general method is presented to diagonalize the hamiltonian of particles of arbitrary spin. In particular the cases of spin 0, $\frac{1}{2}$, and 1 are studied and it is seen that for spin $\frac{1}{2}$ the transformation agrees with Foldy's. The expression for different observables for particles of spin 0 and 1 in the new representation is obtained. (auth)

REACTOR TECHNOLOGY

General and Miscellaneous

4703 (R59FPD936) PROGRAM TRIXY—MULTIGROUP ANALYSIS OF NUCLEAR REACTORS IN THREE SPACE DIMENSIONS (FOR THE IBM TYPE 704 COMPUTER). F. B. Banan, O. S. Clendinning, D. B. Vollenweider, C. H. Warlick, and D. H. Watson (General Electric Co. Flight Propulsion Lab. Dept., Evendale, Ohio and Knolls Atomic Power Lab., Schenectady, N. Y.). Apr. 20, 1960. 175p. OTS.

TRIXY is a computer program which provides a multigroup analysis of nuclear reactors in three space dimensions. The program can be run on an IBM 704 computer that has at least 8192 words of memory and six tape units. The input data consist of cross sections, geometrical configurations describing the location of material within the reactor, control rod positions, mesh spacing for the three axes, and boundary conditions. For each energy group, g, the program computes ϕ, the neutron flux, by a numerical approximation to the age-diffusion equation. When ϕ been calculated for all groups, the fission source, S, is computed. The criticality and source error are calculated and printed. If the fission source has not converged to the degree of accuracy requested, S is recomputed. The results of the program are edited so that values of flux and power density for any section of the reactor can be printed. (auth)

4704 (AEEW-R-36) A REPORT ON THE ZENITH EXPONENTIAL EXPERIMENTS. I. R. Cameron, G. H. Kinchin, and J. E. Sanders. United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Establishment, Winfrith, Dorset, England. Aug. 1960. 45p. BIS.

Exponential experiments on a series of highly enriched uranium–thorium–graphite systems are described. The results of the experiments are correlated on two-group and age-diffusion theory models. (auth)

4705 (ANL-6173) REACTOR PHYSICS MEASUREMENTS IN TREAT. F. Kirn, J. Boland, H. Lawroski, and R. Cook. Argonne National Lab., Ill. Oct. 1960. 52p. Contract W-31-109-eng-38. OTS.

The Transient Reactor Test Facility (TREAT) is a homogeneous graphite-moderated reactor built at NRTS, as part of the AEC Fast Reactor Safety Program. Its primary purpose is to provide a facility where fast-reactor fuel elements may be tested and observed by subjecting them to the in situ conditions one might expect to encounter in a fast-reactor excursion. The reactor operation was extensively investigated under both steady-state and transient conditions. Appropriate physics and operational experiments were performed, and results show that the reactor responds in a safe and predictable manner. (auth)

4706 (ANL-6193) STUDY OF THE PACKED-BED FUEL ELEMENT CONCEPT. M. B. Rodin. Argonne National Lab., Ill. Aug. 1960. 55p. Contract W-31-109-eng-38. OTS.

A preliminary study on the application of packed-bed technology to the design of nuclear fuel elements is presented. The study is limited primarily to problems in materials, fluid flow, and heat transfer, and to particles 50 to 300 μ in diameter. Factors affecting bed performance, such as particle size and shape, bed porosity, and system pressures, were studied. It is indicated that packed beds can be designed to operate at high temperature and high power density, and methods for calculating bed performance are provided. It appears that containment of fission products within the particles in the sizes of interest would be difficult. For purposes of illustration the study describes two potential reactor concepts, one for breeding and one for rocket propulsion. The breeder concept studied the use of a helium-cooled bed of 200-μ UO_2 fuel particles; the coolant is heated from 150 to 980°C at which a peak fuel power density of 3.75 Mw/l is achieved. The propulsion concept studied the use of a hydrogen-cooled bed of 200-μ UC fuel particles; the coolant is heated from 93 to 2320°C, and a peak fuel power density of about 11 Mw/l is reached. In addition, the studies show that a helium-cooled UO_2 bed can be operated as high as 8 Mw/l of fuel for extended periods and the hydrogen-cooled UC bed can be operated as high as 50 Mw/l, with 100-μ particles for short periods. The study notes the highly empirical nature of theory in packed-bed technology and describes a program of research and development which is deemed necessary to provide data for use in designing packed-bed fuel elements for reactors. (auth)

4707 (ANL-6227) SPECIAL LECTURES ON THE PHYSICAL FOUNDATION OF REACTOR ANALYSIS. Paul J. Persiani. Argonne National Lab., Ill. Oct. 1960. 40p. Contract W-31-109-eng-38. OTS.

A treatise is presented on the physical foundation of reactor analysis. This treatise was the result of a series of lectures designed to present reactor physics in a systematic and rigorous manner. Topics covered include the Boltzmann transport equation, velocity and angular moments of the Boltzmann equation, the eigenvalue problem, kinematics of scattering, diffusion-age approximation, the method of groups, adjoint equations, and perturbation theory. (W.D.M.)

4708 (ANL-6253) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT [FOR] OCTOBER 1960. (Argonne National Lab., Ill.). Nov. 15, 1960. 64p. Contract W-31-109-eng-38. OTS.

Research and development activities are reported on EBWR, BORAX-V, ZPR-III, ZPR-VI, ZPR-IX, Juggernaut, EBR-I, and EBR-II. Fast- and thermal-reactor safety studies are summarized. Nuclear technology and general support are treated in terms of applied nuclear and reactor physics, reactor fuels and materials, reactor components, separations, and advanced reactor development. (For preceding period see ANL-6234.) (W.D.M.)

4709 (CRIO-950) EXPERIENCE WITH SLIME FORMING ORGANISMS IN CHALK RIVER REACTOR SYSTEMS. R. E. Manson and I. L. Ophel (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Sept. 1960. 22p. (AECL-1124). AECL.

Operating problems resulting from slime formation in Chalk River reactors are reviewed, and some treatments are outlined. The slime accumulates in cooling system pipes, tanks, strainers, fuel channels, and heat exchangers, causing lower flow rates and heat transfer. Accumulated slime can dislodge suddenly, causing obstructions. Turbidity and radiation problems are caused in rod-storage trenches. Flocculation normally removes most slime-forming organisms from river water. Chlorination is effective in preventing growth, but cannot be used in aluminum systems because of corrosion. An $Na_2Cr_2O_7$ solution was effective against Pseudomonas. For removal from heat exchangers a 2% citric acid solution with 0.5% detergent was used, followed by chlorination to prevent growth. For the rod-storage trenches, circulation through filters and ion exchangers was employed. (T.R.H.)

4710 (DP-517) REACTOR STABILITY. Daniel S. St. John. Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C. Sept. 1960. 88p. Contract AT(07-2)-1. OTS.

Notes prepared for a seminar on reactor stability are presented. Laplace transform notation is introduced, and the transfer functions of simple reactor systems with temperature coefficients and coolant loops are derived and examined for stability. The machine computation of the complete set of nonlinear reactor equations is illustrated. Methods of measuring transfer functions of operating reactors are considered. The approximate transfer functions for higher spatial modes of the flux distribution in large reactors are derived. (auth)

4711 (GA-1660) THE EFFECTS OF ATOMIC MOTIONS ON THE MODERATION OF NEUTRONS. Donald E. Parks (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 17, 1960. 31p. Project 32.210. OTS.

A first-order differential equation is presented for the neutron spectrum in an energy region where the effects of chemical binding are significant but not dominant. Solutions of the differential equation provide accurate results for the spectrum in the cases of moderation by hydrogen, as well as by the heavier moderators, such as beryllium and graphite. In the derivation of the results, no restrictions are made concerning the nature of the motions of the moderator atoms. Interference effects in the neutron scattering are, however, neglected. The integral properties of the scattering kernel, which are found to influence the spectrum significantly, are calculated by means of the short-collision-time approximation, first introduced by Wick to compute the effects of chemical binding on slow neutron-scattering cross sections. Finally, for heavy moderators the representation of the energy-transfer properties of the moderator in terms of a first-order differential operator are combined with the P_1 approximation

to give a useful description of the spatially dependent spectrum. (auth)

4712 (HW-62413) COMMENTS ON ENGINEERING REVIEW OF PRTR BY ATOMIC POWER EQUIPMENT DEPARTMENT. General Electric Co. Hanford Atomic Products Operation, Richland, Wash. Oct. 15, 1959. 40p. Contract AT(45-1)-1350. OTS.

The Atomic Power Equipment Department of the General Electric Company recently made an engineering review of the Plutonium Recycle Test Reactor relative to core performance, reactor mechanical design, refueling-system design, safety features, and analyses of the moderator, helium, and secondary coolant systems. Comments relating to the action to be taken on these review recommendations, made by the Hanford staff of Reactor and Fuels Research and Development Operation, are presented. (C.J.G.)

4713 (HW-64446) A MATHEMATICAL AND STATISTICAL APPROACH TO THE DESIGN AND ANALYSIS OF A REACTOR CONTAINMENT VESSEL PRESSURE TEST. W. L. Nicholson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 23, 1960. 21p. Contract AT(45-1)-1350. OTS.

The mathematical and statistical questions concerned with the estimation of a leak rate from data collected during a reactor containment vessel pressure test are discussed. A mathematical model is suggested for the construction of a total number of gas molecules in the containment vessel time series. A method, based on least squares, for estimating leak rate is given. The techniques discussed were applied to the Phase I PRTR vessel pressure test data. Statistical analysis showed a leak rate estimate of 0.0002 volume fraction per day. Allocation of thermocouples within the vessel for better temperature monitoring and corrections for partial water vapor pressure are discussed. (M.C.G.)

4714 (HW-65578) THE STUDY OF MULTI-REGION REACTORS WITH AN ANALOG COMPUTER. J. C. Peden. General Electric Co. Hanford Atomic Products Operation, Richland, Wash. July 1, 1960. 52p. Contract AT(45-1)-1350. OTS.

A method is presented that illustrates how multiregion nuclear reactors may be studied by the use of a general-purpose analog computer. Group diffusion methods are used, with specific recourse to the two-group theory, although any number of energy groups may be considered, depending upon the available equipment. Finite-difference equations are presented for cylindrical coordinates only; however, similar equations for other coordinate systems may be derived with the same techniques. The analog simulates the critical condition in the reactor and also yields the radial distribution of the neutron fluxes. A comparison is made between the analog solution and an analytic solution. A discussion of the errors and the stability of the computing circuits also is presented. (auth)

4715 (NAA-SR-5610) AN ENRICHED UO_2–ZrH CRITICAL ASSEMBLY. M. V. Davis, A. W. Thiele, and L. I. Moss. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Nov. 1, 1960. 34p. Contract AT-11-1-GEN-8. OTS.

The SNAP Critical Assembly is a pseudospherical nuclear reactor with a fixed hydrogen moderator, 93.17% U^{235} fuel, and a beryllium and graphite reflector. The core is made up of segments of cold pressed ZrH with 8% by weight UO_2 powder. The assembly is constructed in two hemispheres with horizontal faces which are brought in contact. Instrumentation and reactivity, activation, and intrinsic behavior measurements are discussed. (W.D.M.)

4716 (NAA-SR-Memo-3544) ANALYSIS OF GAS-ACTUATED TRIGGER FOR POWER-REACTOR SAFETY DEVICE. J. H. Bick. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Feb. 27, 1959. 20p. OTS.

Reactor-fuse designs were investigated. One design comprised a cylinder of $B^{10}F_3$ heated by the $B^{10}(n,\alpha)$ reaction and a second comprised a cylinder of CO_2 heated by radiation from wires of U^{235}. Only the first design appears promising. (J.R.D.)

4717 (NAA-SR-Memo-5307) PRELIMINARY RESULTS OF STEP INPUT TRANSIENTS IN THE KEWB "B" CORE. R. K. Stitt. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. June 1, 1960. 11p. OTS.

A review of preliminary data obtained with the KEWB B core on step-input transients is presented. These transients were run with periods ranging from 0.53 sec to 0.3 msec. Results are included. (J.R.D.)

4718 (NAA-SR-Memo-5534) BURNABLE AND NON-BURNABLE POISON MIXTURES WHICH IMPROVE REACTOR OPERATING CHARACTERISTICS. J. H. Bick. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. [1959?]. 18p. OTS.

The benefits to be derived from using mixtures of two or more isotopes or elements as poisons in a reactor are investigated. The effects of mixtures on temperature defect and temperature coefficient are discussed, and sample calculations are presented. (W.D.M.)

4719 (NDA-2131-19) RESONANCE ABSORPTION IN D_2O LATTICE REACTORS. W. L. Brooks and H. Soodak. Nuclear Development Corp. of America, White Plains, N. Y. Sept. 30, 1960. 35p. Contract AT(30-1)-2303(IX). OTS.

An attempt is made to develop a direct calculation of the neutron resonance absorption based on Hellstrand's measurements of resonance integrals and on microscopic cross-section data, with no adjustments to fit buckling data. The problem is defined and a description of the proposed method and details of the calculation procedure are given. (W.D.M.)

4720 (PB-151987) TENTATIVE STRUCTURAL DESIGN BASIS FOR REACTOR PRESSURE VESSELS AND DIRECTLY ASSOCIATED COMPONENTS, (PRESSURIZED, WATER COOLED SYSTEMS). Revised Dec. 1, 1958. 162p. OTS.

A structural design basis is presented which establishes general loading assumptions, performed and design criteria, and essential minimum limitations for assuring acceptable structural reliability and safety of reactor pressure vessels and directly associated components under individual and designated combinations of loading requirements specified for a particular installation except for shipboard. (J.R.D.)

4721 (TID-6940) CEPTR—AN IBM-704 CODE TO SOLVE THE P-3 APPROXIMATION TO THE ONE-VELOCITY TRANSPORT EQUATION IN CYLINDRICAL GEOMETRY. P. B. Daitch, B. J. McGovern, and M. Schilder. Combustion Engineering, Inc. Nuclear Div., Windsor, Conn. Sept. 11, 1959. 41p. (MPC-20). OTS.

CEPTR is an IBM-704 code to solve the P-3 approximation to the one-velocity transport equation in cylindrical geometry. The code is limited to 151 spatial points and ten

material regions. The external boundary condition may be specified as reflecting or vacuum or a special type of cell condition. The external source may be specified by region or pointwise. The maximum computer running time for a CEPTR problem is 90 sec. (auth)

4722 (WAPD-T-1156) NONLINEAR EFFECTS ON SPATIAL POWER DISTRIBUTION TRANSIENTS AND OSCILLATIONS WITH XENON REACTIVITY FEEDBACK. S. G. Margolis and S. Kaplan. Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh. June 1960. 13p. Contract AT-11-1-GEN-14. OTS.

Presented at the American Nuclear Society Meeting, June 12-15, 1960, Chicago.

A modal method retaining nonlinear terms is applied to the analysis of xenon reactivity feedback on spatial power-distribution transients and oscillations in a uniform ring reactor. (C.J.G.)

4723 (CEA-tr-R-880) THÉORIE D'UN RÉACTEUR HÉTÉROGÈNE AVEC DES CARTOUCHES CYLINDRIQUES DE RAYON FINI. (Theory of a Heterogeneous Reactor with Cylindrical Elements of Finite Radius). A. D. Galanin (Galanine). Translated into French. [1959?]. 19p.

A coherent theory was established for a heterogeneous reactor with cylindrical elements of a finite but small radius. The thermal neutron density in the element and in the moderator was treated by means of the angular parameters. In the total volume of the reactor, diffusion theory was applied in parallel and perpendicular directions with an approximation to the first power of the ratio of the element sections and the adjoining cell. It is shown that the average diffusion length in the perpendicular direction depends on the shape of the element. A simple method is given for determination of the scattering tensor for a low absorption and a great distance between the elements. (tr-auth)

4724 MONITORED SAFETY SYSTEMS FOR REACTORS. N. Hemmer and H. Wilimzig (Siemens & Halske A. G., Karlsruhe, Ger.). Atompraxis 6, 392-6(1960) Oct.-Nov. (In German)

The probability of hazardous and nonhazardous breakdowns in a monitoring system for nuclear reactors was determined. It is shown that the probability can be considerably reduced by line monitoring of the selection system. (auth)

4725 NUCLEAR INSTRUMENTATION OF REACTORS. II. SPACE MONITORING AND MONITORING OF FUEL ELEMENTS AND NEUTRON FLUX. W. Zumach. Atompraxis 6, 397-404(1960) Oct.-Nov. (In German)

Problems of radiation monitoring arising in the operation of reactors are discussed. Starting from the activation of the coolant, several possibilities of detecting activity in fluid or gaseous cooling media are described. In this connection, some formulas were given which made it possible to constitute the connection between the signal (pulse rate or current) and the concentration of activity. The different methods of fuel-element control are discussed. The measurement of neutron flux and period is considered. The monitoring of rooms entered by personnel is discussed. (auth)

4726 CONTROL PROBLEMS IN REACTORS. Dietrich Bünemann (Gesellschaft für Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg) Kerntechnik 2, 297-300(1960) Oct. (In German)

Possibilities for the design of an automatic reactor control were illustrated in outline by simple examples. The control of oscillations and perturbations in continuous reactor operation is considered. (tr-auth)

4727 THE APPLICATION OF SIMULATORS IN REACTOR TECHNOLOGY. William Alfred Havranek (Miles Electronics Ltd., Shoreham-by-Sea, Sussex, Eng.). Kerntechnik 2, 307-12(1960) Oct. (In German)

After a brief introduction the application of reactor analog computers with special units to the simulation of reactors and the solution of control problems is considered. Various parts of the simulator system were introduced by means of two installations. A discussion of the application of analog computers to power reactors is then given. Education simulators for operational personnel were also described. (tr-auth)

4728 METHOD FOR THE CONTROL OF A REACTOR. W. Gutmann. Kerntechnik 2, 312(1960) Oct. (In German)

Possibilities for the regulation of the neutron flux in reactors by displacement of the center of gravity (for example, on ships) are reported. (tr-auth)

4729 SCRAM DEVICE FOR THE RAPID SHUTDOWN OF REACTORS. W. Gutmann (to Metropolitan-Vickers Electrical Co. Ltd. and United Kingdom Atomic Energy Authority). German Patent DAS 1 075 757. Feb. 18, 1960. Kerntechnik 2, 339(1960) Oct. (In German)

With the device described a scram procedure could be carried out in which boron rod on drive elements and a magnetic braking device were let into or withdrawn progressively to the activity of the reactor in the core itself. A schematic representation of the device is given, and the operation is described.

4730 NEW DEVICE FOR THE MONITORING OF THE RADIOACTIVITY OF THE COOLANT WATER CIRCUIT IN REACTORS. (to LICENTIA Patant-Verwaltungs-G.m.b.H.). German Patent DAS 1 067 141. Oct. 15, 1959. Atompraxis 6, 458(1960) Oct.-Nov. (In German)

A device for the monitoring of the radioactivity of the water coolant in reactors which uses scintillation detectors responding to β radiation is described. In the water circuits under high pressure and temperature, a glass body is introduced. The surface of the glass body averts the coolant to the cathode surface of a photomultiplier, the side of which exposed to the water is covered with a scintillation material such as zinc sulfide. This scintillation layer should be covered with β-permeable foil which reflects the light arising in the scintillator and simultaneously protects the layer from attack by the coolant. A permanent protection of the scintillation layer was guaranteed and an optimum light yield was made possible. Vapor-deposited aluminum was proposed as the protective layer. (J.S.R.)

4731 NEW TYPE OF REGULATION INSTALLATION FOR A BOILING WATER REACTOR WITH DOUBLE CIRCULATION SYSTEM. (to General Electric Co.). German Patent DAS 1 074 169. Jan. 28, 1960. Atompraxis 6, 458(1960) Oct.-Nov. (In German)

A control valve of the low pressure system fed from the reactor, which is controlled by the changes of the consumption load, and a control valve of the high pressure system fed from the reactor, which is controlled by the pressure changes of the high pressure system, and a shunt valve in the high pressure system, which leads the high pressure steam to a condenser, must be connected with each other.

The connection is done by control apparatus in such a way that charge changes in the low pressure system affects the throughput so that the pressure in the reactor remains constant. Control of the reactor should be possible over a wide charge range without hand operation of the control rods. (J.S.R.)

4732 EDDY CURRENT FLOWS FOR THE RELEASE OF THE DROP MOTION OF A SAFETY ROD IN A NUCLEAR REACTOR. (to Metropolitan-Vickers Electrical Co., Ltd. and United Kingdom Atomic Energy Authority). German Patent DAS 1 075 757. Atompraxis 6, 458(1960) Oct.-Nov. (In German)

In the operation of reactors during a rapid shutdown, the problem occurs of moving a neutron-absorbing mass, in the form of rods, as rapidly as possible over the largest part of its exactly defined stroke range and then stopping the mass in the remaining part of its stroke. By the patent proposal not only should the coupling axle be able to move unchecked, but also a progressive braking is possible with eddy currents. For this purpose a permanent magnet eddy current brake is proposed, the magnetic flux of which is short-circuited. The negation of the magnetic current occurs by an eddy current circuit whose rotation corresponds to the drop motion of the scram rods, and which determines the measure to which the short circuiting of the magnetic current was negated. (J.S.R.)

4733 THE ADAPTATION OF THE DENSITY OF THE MODERATOR LIQUID CIRCULATING IN A REACTOR FOR THE CONTROL OF ITS OPERATION. (to Commissariat à l'Énergie Atomique). German Patent DAS 1 079 753. Aug. 14, 1960. Atompraxis 6, 458(1960) Oct.-Nov. (In German)

The new method for the control of the operation of a reactor consists in controlling the mass of the liquid moderator circulating in the reactor in a time unit in such a way that the output decreases when the acceleration produces an increase of the liquid density in the moderator zone of the reactor and that it increases conversely when the acceleration causes a decrease of the density. The proposal should find application in reactors exposed to motion such as vertical reactors on ships. Irregularities in the operation of the reactor would be correspondingly reduced. (J.S.R.)

4734 DEVICE FOR THE CONTROL OF STEAM-PRODUCING REACTORS. (to Societé Anonyme Cockerill-Ongrée). German Patent DAS 1 083 947. June 23, 1960. Atompraxis 6, 458(1960) Oct.-Nov. (In German)

A simple and safe control device for steam-producing reactors is given which changes the flow-through mass of the primary coolant in dependence on the effective output of the reactor so that costly control devices are not necessary. The novelty of the patent consists in that the circulation of the primary coolant is affected directly by the steam produced. The flow-through mass of the primary coolant should be proportional to the steam output. In this manner the advantage is that the power expenditure necessary for the forced circulation of the primary coolant has directly and automatically the least value necessary dependent on the mass of usable steam produced. The automatic change of the necessary mass of primary coolant exerts influence on the nuclear reactivity of the core and therefore on the temperature ratios so that costly control and operation devices are superfluous. (J.S.R.)

4735 SAFETY CONTROL BY THERMAL RESOLUTION OF A NEUTRON-ABSORBING MATERIAL ARRANGED INSIDE A REACTOR. (to U. S. Atomic Energy Commission). German Patent DAS 1 083 948. June 23, 1960. Atompraxis 6, 458(1960) Oct.-Nov. (In German)

A safety control for reactors which shuts down the reactor in case of a runaway is described. In contrast to the usual control devices which are outside the reactor, and which must be introduced into the reactor, the proposal is made to arrange a neutron-absorbing material inside the reactor core. A special arrangement should increase the efficiency of the neutron absorber for the neutron flux. This arrangement can be solved by a predetermined value of the thermal neutron flux. Several devices, such as fuses, highly compressed neutron-absorbing gases, etc., are proposed. The neutron absorbent should generally improve its response to the neutron flux by increase of its surface area. (J.S.R.)

Power Reactors

4736 (ACNP-6005) PATHFINDER ATOMIC POWER PLANT INTERIM PROGRESS REPORT OF REACTOR SYSTEM DYNAMIC ANALYSIS WITH PATHFINDER TRANSIENT SIMULATOR. J. T. Stone, D. Mohr, and R. Schlicht (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Mar. 15, 1960. 62p. For Northern States Power Co. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. OTS.

An explanation and summary of dynamic analyses of Pathfinder performed on the Allis-Chalmers analog computer up to March 31, 1960, are presented. The Pathfinder Transient Simulator and the assumptions used in its derivatives are described. Solutions to problems that have been solved by the simulator are presented. Among the advanced features that are considered in the analysis are the forced recirculation system and the integral nuclear superheater. (W.D.M.)

4737 (ACNP-6006) PATHFINDER ATOMIC POWER PLANT TECHNICAL PROGRESS REPORT, JANUARY 1960–MARCH 1960. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). June 15, 1960. 209p. For Northern States Power Co. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. OTS.

Technical progress on the research and development program being performed in connection with the design of the Pathfinder Atomic Power Plant is reported. Conceptual engineering and component research and development are well under way, and erection of a number of major experimental facilities, which will provide important design data, has been completed. A critical experimental facility was constructed and is now in operation. Fuel-element research and development, reactor mechanical studies, nuclear analysis, chemistry, instrumentation and control, plant safety analysis, feasibility studies, and steam plant and reactor auxiliary system design are covered. (For preceding period see ACNP-6001.) (W.D.M.)

4738 (ACNP-6007) PATHFINDER ATOMIC POWER PLANT TECHNICAL PROGRESS REPORT, APRIL 1960–JUNE 1960. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Oct. 15, 1960. 189p. For Northern States Power Co. and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. OTS

4739 (APAE-58(Rev.)) SM-1 RESEARCH AND DEVELOPMENT "TASK XV" ZERO POWER EXPERIMENTS FOR SM-1 CORE II AND SM-1A CORE I. R. A. Robinson, S. H. Weiss, W. J. McCool, and E. W. Schrader (Alco

Products, Inc., Schenectady, N. Y.). Oct. 12, 1960. 92p. Contract AT(30-3)-326. OTS.

A zero-power experiment on the SM-1 core II included an element-by-element reactivity check of fuel elements and control-rod absorber sections, and an estimate of burnable nuclear poison loading in stationary fuel elements. An approach to criticality was made by the inverse multiplication method, and critical rod-bank position obtained as a function of fuel loading up to full core loading. Minimum and maximum core reactivity measurements were obtained by selective loading of stationary fuel elements, and total excess K of the core was established. Power distribution measurements were taken in the regions of the core-reflector interface and the fuel-absorber interface in the control-rod assemblies. The effectiveness of europium flux suppressors in the top of control-rod fuel elements was determined, and power peaking was measured in stationary elements adjacent to control-rod assembly water gaps. Survey measurements established the worth of spiking clean, cold SM-1 cores with SM-2 elements and the worth of water holes in the SM-1 core. The reduced scope zero-power experiment performed on SM-1A core I included an element-by-element uniformity check of stationary fuel elements, a core assembly test, comparison of Eu_2O_3 and B_4C absorber sections, and development of initial core loading procedures for the SM-1A plant. (auth)

4740 (APAE-63) VAPOR CONTAINER CONCEPTS STUDY FOR SM-2. H. F. Van Kessel and M. J. Celantano. Alco Products, Inc., Schenectady, N. Y. May 16, 1960. 64p. Contract DA-44-192-ENG-7. (AD-238033)

A number of vapor-container concepts were developed for the SM-2. Installation of major equipment within the vapor container, as well as secondary shielding, spent-fuel handling and storage, and the position of the vapor container relative to grade were considered essential parts of each vapor-container concept. Relative cost figures were calculated for each concept. After comparison of these cost figures and other pertinent factors a selection was made of the most suitable vapor-container concept for the SM-2. The selected concept consists of a vertical cylinder of the smallest feasible diameter (20 ft), with the use of earth backfill for secondary shielding and horizontal spent-fuel transfer. (auth)

4741 (APAE-67) EFFECT OF SUPERHEAT AND MOISTURE SEPARATION ON THE SM-2 DESIGN. E. F. Phelps. Alco Products, Inc., Schenectady, N. Y. May 27, 1960. 141p. Contract DA-44-192-ENG-7. (AD-238947).

The study evaluates the utilization of superheat and moisture separation techniques in the SM-2 design to improve the steam plant reliability and thermal efficiency. Ease of packaging, steam plant transient response, and capital costs are also considered. The reference design used for comparison is the steam cycle employing saturated steam at 600 psia. Results indicate that a steam plant cycle using steam at 23.4°F superheat and 480 psia at the steam generator outlet nozzle, along with external and internal moisture separation facilities in the turbine steam path, offers the greatest advantages of all cycles studied. The effect of steam storage volumes such as turbine steam chest, feedwater heater extraction lines, and moisture separators on the load transient behavior of the turbine generator was investigated as part of the study. Since the frequency specifications of the SM-2 allow only very small fluctuations in frequency during load transients, the time lags introduced by additional steam storage volume in the turbine steam path become very objectionable. This was the deciding factor in rejecting the use of reheat in the SM-2 cycle. (auth)

4742 (APAE-68) CONCEPTUAL DESIGN OF SM-2 12,000 ekw POWER COMPLEX. (Alco Products, Inc., Schenectady, N. Y.). May 27, 1960. 135p. Contract DA-44-192-ENG-7. (AD-237575).

A feasible plant is described which is capable of meeting the stringent requirements of operation and control necessary for Nike-Zeus application. The basic plant consists of two 28 Mw(t) pressurized water reactor systems, vertical steam generators, and five 4 kw steam turbine-generators. Normal operation of the power complex is with four turbines operating at 75% of full rated load and steam supplied by the two reactor systems. Three oil-fired boilers are provided as standby sources of energy. (W.D.M.)

4743 (ARL-TR-60-303) CALCULATION OF COLLISION CROSS SECTIONS BY USE OF RELAXATION TECHNIQUES. Period [covered]: May 1959 to June 1960. Emil J. Hellund. Plasmadyne Corp., Santa Ana, Calif. Aug. 1960. 33p. Project No. 7073. Contract AF33(616)-6698.

Methods of calculating collision cross sections and the advantage of using the "relaxation method" are discussed. IS-2S and IS-2P excitation reactions of electron with hydrogen atoms are calculated. The detailed steps of calculus are outlined, and the computed results are compared with those by experiments of other investigators. Interpretations on the discrepancies by different authors are made and discussed. Further applications of the relaxation method are suggested. (auth)

4744 (BAW-1147) EXTERNALLY COOLED LMFR—A REFERENCE DESIGN FOR LOW COST POWER. Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va. Mar. 1960. Changed from OFFICIAL USE ONLY Oct. 18, 1960. 134p. Contract AT(30-1)-1940. OTS.

A 315-Mw(e) Liquid Metal Fuel Reactor Plant (LMFR) is described in detail. Previous LMFR designs (single- and two-fluid, externally and internally cooled) have been optimized to achieve the lowest unit electrical cost. The reference design is a single-fluid reactor containing thorium and uranium in bismuth as fuel and fertile slurry. The slurry particles are not soluble in liquid bismuth. The initial charge and feed fuel is U^{235}. The single-fluid design does not require separate heat transport loops for the blanket. Other technical advantages include a 20-year fuel processing cycle and a relatively simple reactor design. With a plant capacity factor of 80%, the unit electrical energy cost is 7.3 mills/kwh, including about 1.0 mill/kwh for maintenance. A separate, detailed analysis of maintenance costs and procedures is presented in view of the importance of maintenance to the economics of fluid fuel reactors. (auth)

4745 (BAW-1156-1) FEASIBILITY STUDY OF A HIGH TEMPERATURE INTEGRAL LIQUID METAL FUEL REACTOR FOR LOW COST POWER. Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va. Apr. 1960. Changed from OFFICIAL USE ONLY Oct. 18, 1960. 124p. Contract AT(30-1)-1940. OTS.

A preliminary study to determine the technical and economic feasibility of a 315-Mw(e) high-temperature integral liquid-metal-fuel reactor (HTIR) is described. The HTIR houses the complete primary system (reactor, pumps, and tantalum heat exchanger) in a single vessel. Temperatures as high as 1300°F are achieved by (1) constructing the heat

exchanger of tantalum and (2) using a flow path that exposes the vessel to fuel at 1100°F during normal operation. Experimental data show that corrosion and mass transfer are negligible in the primary system. The fuel–coolant is a solution of low-enrichment uranium in molten bismuth. The fissionable materials are U^{235} and plutonium; the fertile material is U^{238}. The fuel is chemically processed in batches after long irradiation times. A head-end step (on-site) separates bismuth from the fuel solution; then the final processing is done off-site by a large Purex type plant. Reactor heat is transported from the U–Bi fuel to boiling mercury in the heat exchanger, where steam is generated at 1000°F and 2400 psia. The reactor has a 6770 Btu/kwh net heat rate. (auth)

4746 (BMI-1379(Rev.)) ADDENDUM TO HAZARDS SUMMARY REPORT FOR THE GCRE CRITICAL-ASSEMBLY EXPERIMENTS. Joel W. Chastain, Harold M. Epstein, William S. Hogan, and David A. Dingee (Battelle Memorial Inst., Columbus, Ohio). Sept. 22, 1959. Revised Nov. 14, 1960. 31p. Contract W-7405-eng-92. OTS.

Critical experiments are described for the ML-1B, a gas-cooled water-moderated reactor. The ML-1B is part of the Army Gas-cooled Reactor Program and is a continuation of previous GCRE critical-assembly studies. The experiments performed with other cores in the GCRE program are listed and results which are applicable to safety are presented. The experimental program and procedures for the ML-1B study are outlined. The safety aspects of the present system are reviewed and several power transients resulting from the sudden insertion of rather large amounts of reactivity are carried out. It appears quite evident that this critical-assembly program can be conducted with reasonable assurance of safe operation and that no public persons are jeopardized by its operation. (auth)

4747 (CF-60-10-85) DRY MAINTENANCE FACILITY FOR THE HRT. P. P. Holz. Oak Ridge National Lab., Tenn. Oct. 11, 1960. 8p. OTS.

A portable shield was designed and fabricated as a dry maintenance facility for the Homogeneous Reactor Test. It is to be used to replace valving and controls, feed pumps, and other small components. (C.J.G.)

4748 (CF-60-10-122) GAMMA-RAY AND FAST NEUTRON HEAT DEPOSITION IN THE EGCR CORE. E. A. Nephew. Oak Ridge National Lab., Tenn. Oct. 28, 1960. 27p. OTS.

The heat deposition rate in the EGCR due to fast neutrons and γ rays has been calculated as a function of position in the core. Based on a source spectrum of 20.74 Mev/fission, the total γ heating in the non-fuel region of the core is calculated to be 3.567 Mw. The detailed distribution of the γ heat deposition in the moderator columns, loop tubes, graphite fuel assembly sleeves and reflector has been determined for the case of a typical reactor power distribution at operating conditions. Heating due to the moderation of fast neutrons is assumed to be proportional to the fast flux distribution in the core. Based on a source spectrum of 5.01 Mev/fission, the total neutron heating in the non-fuel region of the core is calculated to be 2.16 Mw. Thus it is estimated that 6.8% of the total reactor power is deposited outside of the fuel elements. (auth)

4749 (CRCE-979) IODINE CONTAINMENT BY DOUSING IN NPD-II. L. C. Watson, A. R. Bancroft, and C. W. Hoelke. Atomic Energy of Canada Ltd., Chalk River, Ont. Oct. 27, 1960. 44p. (AECL-1130). AECL.

A laboratory investigation has shown that water dousing ensures that most of the iodine in a steam-iodine mixture introduced into a volume of air in which dousing is occurring is transferred to the liquid phase. The distribution ratio of iodine between air and water is approximately 10^{-4} immediately after dousing. Equilibrium with a volatile form of iodine sorbable on charcoal is achieved within 5 min. The distribution is shown to be independent of water quality at low ($<10^{-6}$ M) iodine concentration. The results are of interest in assessing the safety of the NPD-II reactor in which dousing is done to limit pressure rise in the boiler room in the event of rupture of a major high-pressure line carrying hot heavy-water coolant. Such rupture may result in fuel failure with consequent release of volatile fission products, including iodine. (auth)

4750 (DEG-Report-131) SINGLE PRESSURE STEAM CYCLE ANALYSIS. F. Kay (United Kingdom Atomic Energy Authority. Development and Engineering Group, Risley, Lancs, England). Feb. 25, 1960. 36p. BIS.

A method is presented for calculation of the efficiency of a single-pressure steam cycle, which has been programed on the Mercury and the IBM 704 computers at Risley. The computer program is intended for use during parametric surveys of complete power-reactor systems. Consequently, the variables which are fed into the steam-cycle program include reactor coolant temperatures and pinch-point temperature differences, in addition to quantities directly associated with the cycle, such as the steam conditions after expansion in the turbine. Results show the variation of cycle efficiency with the reactor coolant temperatures and pinch-point temperature differences. Limiting coolant temperatures are shown to exist, beyond which the use of a single-pressure steam cycle in a reactor system is not feasible. (auth)

4751 (GAMD-1248) PROGRESS REPORT OF SOME RECENT HTGR NUCLEAR DESIGN STUDIES. I. Bornstein, E. K. Booth, E. H. Buell, and L. A. Seckington. General Atomic Div., General Dynamics Corp., San Diego, Calif. Feb. 10, 1960. 127p. Project No. 32. Contract AT(04-3)-314. OTS.

The main efforts of the HTGR nuclear design program have been directed at obtaining detailed nuclear design information to be used to evolve optimum designs for the metal-clad and graphite-clad HTGR prototypes. Application of the SELECTOR, BURNUP, and MAGNUM computing codes to calculation of design and performance characteristics of the HTGR is discussed in detail. Code development, reactivity and control requirements, flux and power distributions, neutron balance, fuel cost studies, and analysis of Hot Box critical assemblies are considered. (W.D.M.)

4752 (GEAP-3044) SIMULATION OF DRESDEN PRIMARY STEAM DRUM WATER LEVEL CONTROL SYSTEM. J. J. Hogle. General Electric Co. Atomic Power Equipment Dept., San Jose, Calif. July 24, 1958. 18p.

The water-level control system of the primary steam drum of the Dresden Power Reactor is simulated on an analog computer to determine stability and operating characteristics. Both three-element and single-element control modes were stable. Single-element control handled the transient disturbances better. (auth)

4753 (GEAP-3371) NUCLEAR SUPERHEAT PROJECT SECOND QUARTERLY PROGRESS REPORT FOR OCTOBER–DECEMBER 1959. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). 186p. Contract AT(04-3)-189, Project Agreement 13. OTS.

The primary objective of the current work on the Nuclear Superheat Project was to perform the required technical evaluations in order to determine specific areas that are most significant to production of low-cost power from nuclear superheater plants. Preliminary reference design conditions and reactor mechanical configurations were selected for both the integral 200 Mw(e) and separate superheater 325 Mw(e) concepts. Conceptual design studies and preliminary economic evaluations were performed for the separate superheater concept. System analysis studies were made to determine the optimum superheat temperature and pressure for a separate nuclear superheat reactor plant. In the fuel-technology area, results of additional RML evaluations on the first SADE fuel elements are reported. In the corrosion and coolant chemistry area, results from the radiochemistry evaluations on the SADE loop are reported and the design basis is presented for the modifications to the boiling-water corrosion loop to perform superheated steam corrosion evaluations. (W.L.H.)

4754 (IDO-28562) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM MONTHLY PROGRESS REPORT FOR AUGUST 1960. (Aerojet-General Nucleonics, San Ramon, Calif.). Sept. 30, 1960. 95p. Contract AT(10-1)-880. OTS.

The significant highlights of the work performed in connection with the Army Gas Cooled Reactor Systems Program are contained. The program includes the Gas Cooled Reactor Experiment, the ML-1, the Advanced Reactor Systems Project (GCRE-II), and the Gas Turbine Test Facility. The status and progress of each project is reported, as is information concerning associated tests and data evaluation, and status of experimental and prototype components. (For preceding period see IDO-28559.) (W.D.M.)

4755 (NAA-SR-3762) MEASUREMENT OF ZERO POWER FREQUENCY RESPONSE OF THE SRE. J. G. Lundholm, Jr., C. W. Griffin, and E. R. Meise. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Nov. 1, 1960. 58p. Contract AT-11-1-GEN-8. OTS.

The derivation of both the zero power linearized reactor transfer function and the transfer function with feedback due to power and temperature effects in the core is described. The instrumentation and special techniques used to measure these transfer functions are also described. The zero power frequency response function measurements on the SRE confirmed the experimental methods employed. The experimental data correlated quite well with the linearized zero power reactor transfer function, and the measurements provided an experimentally determined value of $1/\beta$. (auth)

4756 (NAA-SR-3763) MEASUREMENT OF THE SRE POWER COEFFICIENTS AND REACTOR PARAMETERS UTILIZING THE OSCILLATION TECHNIQUES. C. W. Griffin and J. G. Lundholm, Jr. (Atomics International Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1, 1960. 54p. Contract AT-11-1-GEN-8. OTS.

Power coefficients and reactor parameters of the Sodium Reactor Experiment were measured using a technique of producing a sinusoidal change in reactivity through oscillation of an existing control rod and measuring the reactor flux and temperature responses by a correlation technique. Individual transfer functions of fuel, moderator, and coolant were determined by isolating individual gains and response times. These transfer functions were used to determine the isothermal temperature coefficients of reactivity and steady-state power coefficients. From these measurements and the unified parameter model calculation, it was found possible to approximate very closely the equations for dynamic stability analysis. (C.J.G.)

4757 (NAA-SR-3764) CALIBRATION OF THE SRE SHIM RODS BY THE OSCILLATION METHOD. C. W. Griffin and J. G. Lundholm, Jr. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Nov. 1, 1960. 25p. Contract AT-11-1-GEN-8. OTS.

Calibrations of the SRE shim rods were obtained by oscillation and period methods. The oscillation and period measurements compared within a scatter of 6% of mean differential worth. Oscillation techniques employed include direct oscillation of a shim rod by means of a Scotch-yoke mechanical drive, direct oscillation of a shim rod by use of the existing relay servo controller, and inserting a known step change of reactivity by rotating a rotary oscillator and observing the change in shim rod position as commanded by the automatic flux controller. Period measurements were performed following the oscillation measurements of each point. The time required for oscillation measurements was less than one-fifth that required for period measurements. Oscillation measurements were shown to have an accuracy equal to or better than period measurements. (auth)

4758 (NAA-SR-5073) PIQUA OMR PURIFICATION SYSTEM DEVELOPMENT. W. N. Bley and R. W. Burkhardt. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Nov. 1, 1960. 65p. Contract AT-11-1-GEN-8. OTS.

A research and development program was conducted to design and test an automatic, continuous purification system for removal of high boiler (HB) decomposition products in the Organic Moderated Reactor being constructed at Piqua, Ohio. Experimental measurements of the latent heats of vaporization of the terphenyl coolant and of the liquid-vapor equilibria were used to design and evaluate the performance of the Piqua Purification Process. A two-stage process, consisting of flash distillation and subsequent stripping of the flash liquid, was designed to purify the terphenyl coolant moderator. A full-scale prototype unit was constructed from this design. Sufficient latitude was incorporated into the design by making it capable of processing 1000 lb/hr of coolant containing 10 wt. % HB. The Piqua Reactor requires a processing rate of 195 lb/hr of coolant containing 30 wt. % HB. A test program was conducted on the prototype unit to evaluate its design and performance. Performance was found to be satisfactory. Process control instrumentation and process equipment performance were also evaluated and found to be satisfactory. (auth)

4759 (NAA-SR-5317) THE SNAP 2 RADIATIVE CONDENSER ANALYSIS. M. G. Coombs, R. A. Stone, and T. Kapus. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. [1960]. 63p. Contract AT-11-1-GEN-8. OTS.

The SNAP-2 power system employs a direct-condensing radiator. In this system, the heat released in the condensation process is radiated to space from a large extended surface, consisting of fins attached to tubes containing the condensing fluid. Aspects of the radiator-condenser design are discussed relative to two-phase flow, heat transfer (condensing, tube to fin, and radiant), meteoroid protection, and reactor-radiator configuration. A procedure is developed for determining a minimum weight heat rejection sys-

tem based on the optimum data determined analytically. (C.J.G.)

4760 (NAA-SR-5348) DESIGN MODIFICATIONS TO THE SRE DURING FY 1960. G. E. Deegan, M. D. Dermer, J. S. Flanagan, G. C. Gower, R. J. Hall, R. B. Hinze, D. H. Johnson, R. W. Keaten, and W. H. Olson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 20, 1960. 106p. Contract AT-11-1-GEN-8. OTS.

Design modifications incurred by the Sodium Reactor Experiment during 1960 are reviewed. Tetralin was replaced by nitrogen gas, NaK, and kerosene as service coolants for the reactor. Modifications to the sodium system are described. Steam replaced water for removing residual sodium from core components. Modifications to instrumentation and fuel-cluster geometry are described. (C.J.G.)

4761 (NAA-SR-Memo-2434) ORIGIN OF WATER VAPOR IN THE GALLERIES. R. P. Nebiker. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Jan. 23, 1958. 7p. OTS.

An investigation was made to locate the source of water vapor in the galleries of the SRE and to estimate the amount of water to be expected during future operational runs. (W.L.H.)

4762 (NAA-SR-Memo-3407) AN INVESTIGATION OF POSSIBLE FLOWMETER TYPES FOR THE LARGE HNPF PIPING. G. E. Turner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 11, 1958. 14p. OTS.

Various types of flowmeters were evaluated for use on large sodium piping of the Hallam Power Reactor relative to availability, cost, and relative merits. Permanent magnet flowmeters were found most applicable. (C.J.G.)

4763 (NAA-SR-Memo-4829) CURRENT CRITERIA FOR THERMAL DESIGN IN OMR'S. T. T. Shimazaki (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 6, 1960. 10p. OTS.

The current criteria for thermal design in organic-moderated reactors are summarized. Heat-transfer coefficients for cooling and heating unirradiated Santowax R and Santowax R with 30% HB flowing turbulently in tubes are given. The critical heat-flux data for unirradiated Santowax OMP are shown. Fouling rates for heating OMRE coolants are shown. The permissible initial surface temperatures for various final cladding surface temperatures are shown. (W.L.H.)

4764 (NAA-SR-Memo-5298) EXPERIMENTAL STRESS STUDIES OF HNPF MODERATOR ASSEMBLIES. H. E. Jackel and R. D. Chipman. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. July 1, 1960. 28p. OTS.

A number of tests were performed to determine the location, direction, and magnitude of strains induced in HNPF moderator assemblies under simulated operating conditions. Test methods are described, and results are presented graphically. (J.R.D.)

4765 (NAA-SR-Memo-5302) ESTIMATE OF XENON REACTIVITY WITH APPLICATION TO THE SER. H. H. Baucom. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. May 19, 1960. 47p. OTS.

An iterative procedure for estimating the xenon reactivity based upon computed initial conditions and build-up functions is developed. Tables of the build-up are presented, permitting easy evaluation of the xenon effect. (W.D.M.)

4766 (NAA-SR-Memo-5423) PREPOISONING OF THE S2DS. Richard Brehm. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. June 20, 1960. 7p. OTS.

The prepoisoning of the S2DS Reactor for Sm^{149} build-up compensation is analyzed. The methods of prepoisoning with Sm_2O_3 are proposed: homogeneous loading in the core, wafers in the fuel, and wafers in the end reflectors. (W.D.M.)

4767 (NAA-SR-Memo-5554) COMPARISON OF CALCULATED AND MEASURED GAMMA-RAY DOSE RATES AND NEUTRON FLUX DISTRIBUTIONS IN THE SRE INSTRUMENT THIMBLES. P. Spiegler. Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Aug. 8, 1960. 59p. OTS.

An attempt is made to predict the thermal-neutron flux and γ-ray dose rate in the various instrument thimbles of the Sodium Reactor Experiment. The Wanda III Code, the GRACE I Code, and neutron and γ-ray streaming theory are employed. Basic cross sections and other physical data used in the calculations are listed. The cases examined include the effect of cutouts in the thermal shield on the neutron flux and γ-ray dose rate at the bottom and up through the instrument thimbles. Agreement with the results of preliminary measurements is found to be reasonable. Reasons for the differences between calculations and measurements are discussed. (auth)

4768 (RADC-TR-60-85) A LOGISTIC STUDY OF NUCLEAR AND CONVENTIONAL POWER PLANTS FOR THULE, GREENLAND. (Burns and Roe, Inc., New York). June 1960. 121p. Project No. 6185. Contract AF30(602)-2095. (AD-238286).

A study was made to determine the comparative costs of logistic support for conventional vs. nuclear facilities as sources of power and steam heat for the Air Force Base and Ballistic Missile Early Warning System (BMEWS) at Thule, Greenland. The existing conventional facilities consist of a floating power ship with three oil-fired boilers and three steam turbines, backed by 27 land-based diesel generators and 43 package type heating boilers. The conceptual nuclear plant is designed to furnish all electric power and heating steam normally produced by the conventional facilities. The results of the logistic cost comparison indicate that an annual savings of roughly $528,600 to $854,000 may be realized by utilizing nuclear power and steam generating facilities in place of the existing conventional facilities. These savings are brought about by drastically reducing the diesel fuel requirements, the transportation costs of which constitute 85% of the conventional plant logistic costs. Development of the study also revealed that an annual savings of approximately $1,000,000 in fuel costs could be realized by utilizing nuclear power. The results of the study indicate that the advantages of lower fuel and logistic supply costs inherent in the nuclear plant should be given serious consideration when the relative merits of conventional and nuclear facilities are compared. (auth)

4769 (SRO-37) HEAVY WATER POWER REACTOR PROGRAM. Monthly Progress Report [for] September 1960. Savannah River Operations Office, AEC. 21p. OTS.

Research and development efforts on heavy-water power reactors by du Pont, Columbia University, Nuclear Metals, Inc., Nuclear Development Corp., and Sargent & Lundy are briefly summarized. Research and development, construction, basic reactor facility, and coolant loops are reviewed for the Heavy Water Components Test Reactor. Developments in the Florida Power Reactor and the Carolinas–Virginia Tube Reactor are discussed. (For preceding period see SRO-36.) (W.D.M.)

4770 (SRO-38) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, OCTOBER 1960. (Savannah River Operations Office, AEC). 19p. OTS.

Research and development activities on heavy-water power reactors by du Pont, Columbia University, Nuclear Development Corporation, Nuclear Metals, and Sargent and Lundy are summarized. Process development, design, and construction of the Heavy Water Components Test Reactor are outlined. Developments in the Florida Power Reactor and Carolinas-Virginia Tube Reactor programs are discussed briefly. (For preceding period see SRO-37.) (W.D.M.)

4771 (TID-6893) A STUDY OF WET STEAM AS A REACTOR COOLANT. Progress Report for the Month of September 1960. Nuclear Development Corp. of America, White Plains, N. Y. Oct. 18, 1960. 26p. Project No. 7. Contract AT(30-1)-2303. (CIS-087). OTS.

Progress is reported on a research and development program to study water–steam mixtures and their use as coolants in light-water-moderated power reactors. All heat-transfer and burn-out tests on round tubes were completed. Corrosion and erosion tests indicated that no detectable damage to Zircaloy and stainless-steel samples results after exposure to fog-flow for 120 to 150 hr with velocities of 200 ft/sec at a coolant temperature of 510°F and a pressure of 750 psi. (W.L.H.)

4772 (WADC-TN-59-415) FAST VERSUS THERMAL REACTORS FOR PROPULSION AND POWER APPLICATIONS. [Period covered]: September 1, 1959 to October 15, 1959. John E. Brooke and Irving A. Peltier (Wright Air Development Div. Propulsion Lab., Wright-Patterson AFB, Ohio). Nov. 30, 1959. 34p. (AD-238401).

Nuclear characteristics of fast and thermal reactors are compared on the basis of effects of moderator concentration on fuel concentration, flux lethargy, and size of reactors. The concentration of moderator is divided into three ranges, from zero to full concentration. In the small range, neither the fuel concentration nor the reactor size is a strong function of moderator concentration, and the flux spectrum is essentially the same as the fission spectrum. Also reactor size, radius, is inversely proportional to the square of the fuel concentration. In the high range, neither the fuel nor the size is a strong function of moderator concentration, but the flux lethargy spectrum shifts to include a very large percentage of thermal neutrons. In the intermediate or transition range, both the fuel and size are strong functions of moderator concentration, and the flux lethargy spectrum shifts very rapidly toward the thermal range when moderator is increased. The reactor size, however, is a very weak function of fuel concentration. The intermediate range for the U^{235}-C reactor is actually about one order of magnitude wide and shifts toward the increasing moderator concentration direction as the size of the reactor decreases. For reactors below a certain size, the transition from no thermalization to maximum thermalization cannot take place, and these reactors have fast or epithermal flux lethargy spectra regardless of moderator concentration. If void space is filled with heavy, nonabsorbing nuclei, fuel concentrations required for fast reactors can be reduced appreciably. This fact points out an apparent disadvantage of gas-cooled reactors over liquid-metal-cooled fast reactors. (auth)

4773 (WCAP-4011) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATED, INC., CVTR PROJECT MONTHLY PROGRESS REPORT. Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh. Feb. 1960. 28p. OTS.

Progress is reported on the construction and testing of the following Parr Shoals Power Reactor components: pressure tube assembly, fuel assemblies, in-pile loop, moderator and shield tank, and instrumentation and control. A preoxidizing treatment of Zircaloy-2 and Zircaloy-4 was found effective in reducing hydrogen pickup. Zirconium phosphate and zirconium oxide beads were successfully prepared for use as ion-exchange materials. Approximate pressure drops across the various components of the pressure-tube assembly were calculated. At operating temperatures in a region of maximum flow, a pressure drop of about 85 psi across the entire U-tube can be expected. Preliminary results of an analysis of the primary coolant system behavior during start-up, failure of power to one pump, and normal shutdown are reported. (For preceding period see WCAP-4009.) (C.J.G.)

4774 (WCAP-4017) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. CVTR PROJECT MONTHLY PROGRESS REPORT. Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh. Mar. 1960. 31p. OTS.

Preliminary results from Phase I Loop D tests indicated that heat losses through the thermal baffles are higher than previously calculated. Preliminary results on thermal cycling tests on a Zircaloy-stainless steel joint indicated a very small leakage rate. Specifications for the prototype control rod drive power unit were prepared. The moderator tank diameter was reduced by one foot when calculations indicated that the reflector thickness could be reduced by 6-in. Steam corrosion tests were conducted on Zircaloy-2 and Zircaloy-4 coupons at 750°F. (For preceding period see WCAP-4011.) (C.T.G.)

4775 (WCAP-4022) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. CVTR PROJECT MONTHLY PROGRESS REPORT. Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh. Apr. 1960. 30p. OTS.

The results of Loop D thermal-baffle heat-transfer tests indicated that coolant was leaking into the baffle region at the break-away joint and piston-ring locations so that the heat losses were 2 to 3 times the predicted value. After the baffles were sealed more effectively, the tests were repeated. Studies to determine the pressure at which local boiling would occur in the reactor during step reductions in power were completed. The results showed that negative pressure swings during such transients need not be restricted to 50 psi as in the case of 100% power operation. Header-assembly layout was completed. The jumper-tube flexibility was found adequate after analyses of thermal-expansion stresses were made. A shielding arrangement was selected for the operating floor in the vicinity of the rotating disk. Preliminary design studies were performed on a modified version of the refueling machine capable of removing and replacing U-tubes containing fuel assemblies. (For preceding period see WCAP-4017.) (C.J.G.)

4776 (WCAP-4027) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. CVTR PROJECT MONTHLY PROGRESS REPORT. Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh. May 1960. 32p. OTS.

A gas (helium) shroud tube was adopted to insulate the pressure tube and moderator from the hot primary coolant in the vicinity of the shield plug. Leak rates were determined for the upper in-pile transition test joint at room temperature using a vacuum system. The modified Phase I-A thermal-baffle tests indicated heat loss to be 27% higher than originally predicted. The higher value is attributed to: (1) conduction at four metal joints in the pressure tube; (2) heat leakage through the U-bend baffle due to its nonvertical geometry; and (3) heat-leakage dependence on the Prandtl number of water. Means of effecting a good seal between the thermal baffles and the pressure tube are being studied. (For preceding period see WCAP-4022.) (C.J.G.)

4777 (WCAP-4029) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. CVTR PROJECT MONTHLY PROGRESS REPORT. Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh. June 1960. 31p. Contract [AT(30-1)-2289]. OTS.

An analysis of pressure-tube bowing, based on the gas-shroud design concept, was made. Tests were conducted which resulted in redesign of the gaskets because of excessive gasket yielding. Cladding thickness for the Phase II fuel assemblies was set at 0.23. The first gaskets from the Conoseal crevice-corrosion program were removed and no significant corrosion was exhibited. The primary-coolant-system design pressure was changed to 1730 psia. A computer study of plant transient behavior with control-rod motion was performed. Designs were prepared for the Al–Cd neutron curtain to be installed in the critical core tank. (For preceding period see WCAP-4027.) (C.J.G.)

4778 (WCAP-4033) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. CVTR PROJECT MONTHLY PROGRESS REPORT. Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh. July 1960. 26p. Contract AT(30-1)-2289. OTS.

Construction of Phase I-B test components (tests on heat loss from pressure-tube assembly) was completed. The Zircaloy–stainless-steel pressure-tube joint using a banana ring gasket was thermally shocked; leak rates of 0 to 10^{-3} lb/hr were indicated. MgO was found unsuitable for use in the thermal-baffle design because of its solubility in water. Tests on the thermal-baffle test facility indicated that the heat leakage was 20% greater than predicted by the Jakob correlation. Fabrication of the critical facility was completed; the critical size was found to be slightly less than 37 4-ft fuel clusters enriched to 1.1%. Flux-perturbation experiments on a nuclear mock-up of the in-pile loop fuel element indicated that most of the fuel rods will operate within 10% of the desired power level. (For preceding period see WCAP-4029.) (C.J.G.)

4779 (WCAP-4037) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. CVTR PROJECT MONTHLY PROGRESS REPORT. Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh. Aug. 1960. 29p. OTS.

Preliminary results of the Phase I-B tests indicated an excessive heat loss in the outlet leg of the pressure tube assembly. The losses are attributed to faulty teflon piston ring sealing at the lower end of the fuel assembly. The thermal-baffle test facility was dismantled for modifications to adapt it to high pressure and temperature testing of thermal baffles. In both high and low moderator level tests in Phase I-B baffles, the gas shroud surrounding the pressure tube was less effective in preventing heat loss than heat-transfer correlations predict for stagnant air gaps. The critical facility core was loaded with 2% enriched 4-ft fuel clusters and criticality was attained with both a 5 by 2 and a 3 by 3 arrangement of the clusters. (For preceding period see WCAP-4033.) (C.J.G.)

4780 (WCAP-4041) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC. CVTR PROJECT MONTHLY PROGRESS REPORT. Westinghouse Electric Corp., Atomic Power Dept., Pittsburgh. Sept. 1960. 25p. OTS.

Phase I-B tests on the pressure tube and fuel assembly showed substantial reduction in the heat losses through the thermal baffles between the fuel assemblies and the pressure tube. Metal seal rings were employed at the lower end of the "inlet" leg fuel assembly and Teflon rings at the top of the "outlet" leg assembly. A ball-cone type of seal was incorporated in the pressure tube design, supplanting the piston-ring type seal. An imperfect weld was found to be the cause of a crack in the sleeve of the Conoseal Zircaloy–stainless-steel joint. (For preceding period see WCAP-4037.) (C.J.G.)

4781 (AEC-tr-4317) WHAT DOES NUCLEAR FUEL COST: A COMPARATIVE STUDY ON THE FUEL CYCLE COSTS OF POWER REACTORS. Wolfgang Finke. Translated for Oak Ridge National Lab. from Atomwirtschaft 5, 204-8(1960). 23p. JCL.

This paper was previously abstracted from the original language and appears in NSA, Vol. 14, abstract No. 17612.

4782 G2: THE FIRST FRENCH ENERGY PRODUCING REACTOR. B. Milliot (Centre d'Etudes Nucléaires, Saclay, France). Ingr.-Constructeur No. 21, 12p(1958) Nov. (In French) (CEA-1077)

A description is given of the first great French industrial reactor. A description of G2 moreover serves also to describe G3. These two units, arranged side by side and constructed within an internal of six months one from the other, differ in fact only in their system for canning failure detection. (auth)

Research Reactors

4783 (FZM-715A) PULSED NUCLEAR RADIATION TESTING OF ELECTRONIC SYSTEMS. (Convair, Fort Worth, Tex.). Apr. 1957. 25p.

Design and economic studies were made on reactors for adaptation for pulsed-radiation testing of electronic systems. The studies indicated that a reactor based upon the BORAX type may be readily adapted for pulsed-radiation testing requiring fast-neutron fluxes greater than 10^{15} neutrons/cm^2/sec and integrated fluxes per pulse greater than 10^{13} nvt. Advantages of utilizing this type of reactor are discussed. (C.J.G.)

4784 (NAA-SR-Memo-2071) AN INVESTIGATION OF THE FEASIBILITY OF REPLACING HELIUM WITH NITROGEN AS A COVER GAS IN CERTAIN SPECIFIED AREAS AS AN ECONOMY MEASURE. C. W. Griffin (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 19, 1957. 5p. OTS.

The feasibility of replacing helium with nitrogen as a

cover gas in a Sodium Reactor Experiment is investigated. The cost of helium is about $23 per 250 SCF and commercial nitrogen is about $2.50 per 250 SCF. Because of the high affinity of zirconium for nitrogen, it is not felt desirable at this time to consider the use of nitrogen as a cover gas in the primary sodium system. With the inclusion of a NaK bubbler and a drier, nitrogen can be used in the secondary system since nitriding of stainless steel is negligible, and it is virtually impossible to form sodium-nitrogen compounds in the system. (W.L.H.)

4785 (NP-9413) RADIATION EFFECTS REACTOR HIGH POWER TEST PROGRAM. R. J. Cashwell and D. E. Kahlson (Lockheed Nuclear Products, Marietta, Ga.). Sept. 1960. 42p. (NR-103).

The performance of the Radiation Effects Reactor under full-power capability tests is described. (C.J.G.)

4786 (NP-9439) CRITICAL EXPERIMENT REACTOR SAFEGUARDS. (LAC-148). (Addendum to LAC-147). [1958]. CRITICAL EXPERIMENT REACTOR REGULATING ROD CALIBRATIONS. R. J. Cashwell (Lockheed Aircraft Corp., Marietta, Ga.). (NR-48). Oct. 1958. 96p. OTS.

The Critical Experiment Reactor is a low-power open-pool type reactor, consisting of a top head complete with drives, a core assembly, an instrumentation system, and a support stand. The active portion of the core is 8 ft below the pool surface. The reactor core may consist of from 16 to 31 fuel elements for criticality, 4 control rods, and 1 regulating rod. Reactor physics and engineering considerations, organizational structure, formulation of procedures, safety responsibilities, operational program, and possible reactor accidents and hazards are discussed in detail. (W.D.M.)

4787 (AD-240191) THE HIGH FLUX REACTOR OF THE NETHERLANDS REACTOR CENTER. M. Bustraan. Translated for Picatinny Arsenal from Chem. Weekblad. 54, 590-603(1958). 37p.

A description is furnished for the Netherlands High Flux Research Reactor based on the design of the ORNL Research Reactor. The reactor is to operate at 20 Mw with an average thermal flux of 1.5×10^{14} neutrons/cm^2. Minimum excess reactivity of the cold clean reactor is 13.2%. Control rods are located underneath the reactor. (W.D.M.)

4788 SUBCRITICAL REACTOR OF NATURAL URANIUM AND LIGHT WATER. C. Sánchez Del Río, E. Rodríguez Mayquez, J. Cuevas, and J. Montes (Junta de Energia Nuclear, Madrid). Anales real soc. españ. fís. y quím. (Madrid), Ser. A 56, 131-6(1960) May-June. (In Spanish)

In the early months of 1957 a subcritical assembly consisting of two tons of natural uranium rods in light water was built. It has been used since, mainly for training purposes. A brief description of the apparatus is given. (auth)

4789 SIMULATION OF THE DYNAMIC BEHAVIOR OF RESEARCH REACTORS. (WATER BOILER AND SWIMMING POOL). Ulrich Kaczmarek (Hartmann & Braun A.G., Frankfurt am Main). Kerntechnik 2, 300-6 (1960) Oct. (In German)

The area of system analysis is concerned with the calculation of the dynamic behavior of plants. The procedure was explained with the examples of water-boiler and swimming-pool reactors. A brief introduction to the analog computer technique is shown by the programming of the bare reactor. The differential equations which describe the temporal behavior of water-boiler and swimming-pool reactors in the stress range are developed. For individual temperatures differential equations of the first order were given. For the water-boiler reactor a possible complete programming was given. (tr-auth)

4790 THE INSTRUMENTATION OF THE KARLSRUHE RESEARCH REACTOR FR-2. Peter Dosch and Ernst Schneider. Kerntechnik 2, 313-18(1960) Oct. (In German)

A general survey is given of the design and instrumentation of the FR-2 Reactor. A cross section of the reactor is given. The instrumentation for the neutron flux measurements and the power control system is briefly described. The monitoring and control of the reactor circuits, the safety system, and the observation and instrumen rooms are examined. (J.S.R.)

4791 SAFETY DEVICES IN THE LINEAR POWER MEASUREMENT CANAL OF THE BERLIN REACTOR. Thomas Friese (Hahn-Meitner Institut für Kernforschung, Berlin). Kerntechnik 2, 322-3(1960) Oct. (In German)

For the linear power measurement canal of the Berlin Reactor a new electrometer and switching circuit was developed. For amplification of the ionization chamber current an industrial electrometer amplifier was used. Mechanical interlocks on the operating and band switches as well as a prealarm, which was released before the limiting value for automatic scram was reached, excluded errors in the operation. (tr-auth)

WASTE DISPOSAL AND PROCESSING

4792 (CRCE-594(Rev.)) ULTIMATE FISSION PRODUCT DISPOSAL. II. THE DISPOSAL OF MODERATELY RADIOACTIVE SOLUTIONS IN A CEMENT MORTAR. J. M. White and G. Lahaie (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1960. 15p. (AECL-1085). AECL.

A method for ultimate disposal of moderately radioactive solutions in a cement mortar is described. The mortar must be placed in a leach-proof container. (C.J.G.)

4793 (HW-53325) RECOVERY OF RADIOACTIVE CESIUM AT HANFORD. B. F. Judson, R. L. Moore, and H. H. Van Tuyl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 23, 1957. Decl. Nov. 13, 1957. 13p. Contract W-31-109-Eng-52. OTS.

Methods for the recovery of radioactive cesium from high-level waste streams, based on precipitation by metal ferrocyanides, are discussed. (C.J.G.)

4794 (HW-66091) SOLIDIFICATION OF HIGH LEVEL WASTES. PART III. SOLUBILITY, MELTING POINT, FLOW TEMPERATURE AND THERMAL CONDUCTIVITY OF SOME CALCINED, SYNTHETIC PUREX-TYPE WASTES. G. B. Barton (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 15, 1960. Decl. Sept. 14, 1960. 31p. Contract AT (45-1)-1350. OTS.

The melting behavior of a number of compositions that approximate high-level Purex waste was observed and the solubility measured on the melted material. The ternary sodium, aluminum, iron phosphate composition was studied over a wide range of typical plant wastes to determine the variation of melting point with composition. The addition of phosphate to wastes appeared most suitable for the pro-

duction of a meltable material with a low solubility. (For Part II see HW-63307.) (C.J.G.)

4795 (HW-66796) SOLID FIXATION OF HIGH-LEVEL RADIOACTIVE WASTE BY SORPTION ON CLINOPTILOLITE–SCOUTING STUDIES. J. L. Nelson, B. W. Mercer, and W. A. Haney (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 4, 1960. 25p. Contract AT(45-1)-1350. OTS.

Combinations of actual and synthetic waste supernatant solutions of four types were decontaminated with mineral beds. The wastes were: neutralized Purex 1ww, neutralized formaldehyde-killed 1ww, Redox D-8, and decladding waste. All major radioisotopes, except Ru^{106}, were reduced below MPC or detection limit for each of the wastes. Since most of the inert salts passed through the columns, volume reduction factors were large, ranging from 27 to 55. Discussions are presented on possible applications, problems, and estimated costs. (W.L.H.)

4796 (JAERI-1012) TREATMENT OF RADIOACTIVE WASTES WITH ION EXCHANGE MEMBRANE ELECTRODIALYZER. Report No. 12. Masukuni Ito and Mutsumi Nishidoi (Japan Atomic Energy Research Inst., Tokyo). Apr. 1960. 25p.

The treatment of low-level radioactive wastes with electrodialysis employing ion-exchange membranes as an economical process was studied. It was found that electrodialyzer JAERI-300B as an ionic unit had advantages for demineralizing brine water, and the electrodialyzer was applied in the treatment of actual radioactive wastes. It is concluded that the transfer rate of nonradioactive and radioactive ions through an ion-exchange membrane was nearly equal and that the electrodialyzer requires no special modification for treating radioactive wastes if it is combined with the treatment plant now operating at JAERI. In the two-stage treatment, the concentration of concentrated effluent from the electrodialyzer rises up to 100 times that of initial feed; so the evaporating cost is reduced markedly and at the same time the concentration of demineralized effluent decreases to one-tenth, and the volume of break-through from the final ion-exchange tower, viz., the ratio of break-through volume to volume of regeneration waste, increases ten times. The power needed for the electrodialysis was found to be only 1 kwh/m^3 when demineralizing from 2000 to 20 ppm. The over-all power needed, including three pumps for feed, circulation, and discharge, was only 10 kwh/m^3. The current efficiency of this electrodialyzer was over 70%. (auth)

4797 (ORNL-2979) CHEMISTRY OF THE INTERCYCLE EVAPORATOR INCIDENT OF NOVEMBER 20, 1959. W. Davis, Jr., W. H. Baldwin, and A. B. Meservey (Oak Ridge National Lab., Tenn.). Nov. 23, 1960. 17p. Contract W-7405-eng-26. OTS.

On November 20, 1959, an evaporator in Cell 6 of the ORNL pilot plant exploded during equipment decontamination operations. From the schedule of operation, associated calculations of chemical inventories, and the results of subsequent laboratory studies of the reactions of the various materials known to be present in the evaporator at the time of the explosion, it was concluded that the explosion was probably the result of rapid reaction of nitric acid and alkali nitrates with phenol contained in a decontamination reagent. Although the phenol contained in the reagent was found to contribute significantly to the violence of reaction, various amines in the formulation also react very vigorously when heated with nitric acid. It is also possible that degradation products of tributyl phosphate, present as cruds, contributed to the explosion. (auth)

4798 (ORNL-3002) A THERMAL PROBLEM ASSOCIATED WITH UNDERGROUND STORAGE OF RADIOACTIVE WASTES. Julian Crowell and F. L. Parker. Nov. 17, 1960. 75p. Contract W-7405-eng-26. OTS.

Aspects of an infinite medium heated by a cavity filled with exponentially decaying sources are examined. The medium selected is rock salt. The deposit surrounding the disposal volume is assumed to be infinite in extent, and the usual rectangular-parallelepiped room and tunnel of salt mines are approximated by a sphere and an infinitely long cylinder. It is also assumed that the thermal conductivities of wastes and salt do not change with temperature, heat is lost only by conduction, there are no phase changes in wastes or salt, and all β and γ radiation is absorbed in the wastes. (J.R.D.)